

SCIENCE

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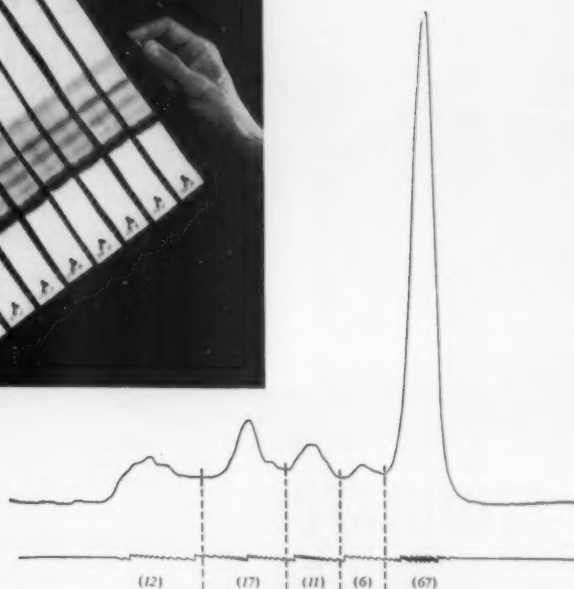
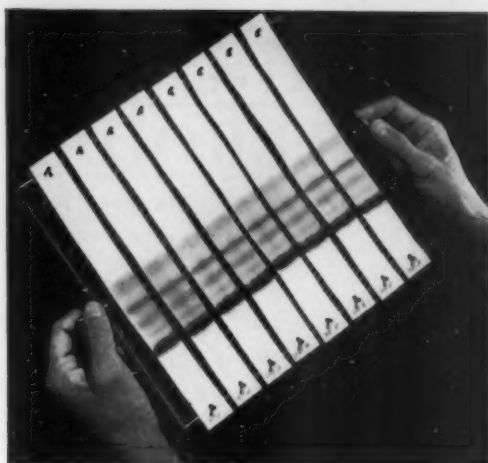
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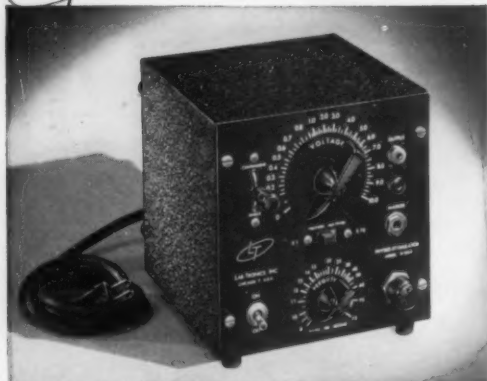
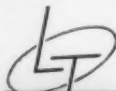
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Foreign Travel

In the 3 years ending last June the National Science Foundation allotted \$150,000 to help send American scientists to international scientific meetings held in other countries. Individual grants were modest and usually covered only the cost of air tourist transportation. Through these grants the foundation assisted 178 scientists to attend such meetings as those of the Mathematical Union in Rome, the Congress of Biochemistry in Paris, the Scientific Radio Unit in Sydney, the Pacific Science Congress in Quezon City, and the World Power Conference in Rio de Janeiro.

Since July the foundation has had no money for such purposes; its request for \$75,000 was stricken from the budget by the House of Representatives Subcommittee and so reported to the House when the appropriations bill was considered. The item was not restored in resolving the differences between the House and Senate appropriations measures. The House action was taken in obvious disregard of the long-recognized values of international travel and communication.

In another sphere the Congress has recognized these values. In 3 months last fall, 41 senators and 109 representatives either made trips abroad or announced definite intentions to make such trips. Their cost cannot be determined, for costs were distributed among unreported amounts of counterpart funds, congressional appropriations, and funds of several federal departments. It is highly probable, however, that the total spent or obligated in 3 months was greater than the total spent by the National Science Foundation in 3 years, for it is known that in fiscal 1955 foreign travel of congressmen cost \$136,000 in counterpart funds alone [*Congressional Quarterly* 12, No. 44 (1955)].

The point of the comparison is not to criticize members of the Congress for visiting other countries. Quite the contrary; granting that congressmen, like ordinary citizens, may play as well as work while traveling abroad, their trips can still be justified. Both our foreign relations and our national welfare can be strengthened by allowing congressmen to gain the firsthand information and impressions about other parts of the world that will enable them to legislate more wisely.

But the value of travel abroad is not limited to members of the Congress and other government officials. The nation's cultural relations have been helped by the European tour of the cast of *Porgy and Bess* and by the travel of scientists and other worthy representatives of our national life. The benefits are partly those of increased knowledge, for the traveler sometimes learns things sooner or more thoroughly than he otherwise would. The benefits also include the maintenance of open channels of communication and good relations with other countries. An obvious example is the desirability of having the United States represented at the International Genetics Congress in Japan next September. But this is one of the meetings to which the National Science Foundation is now barred from giving support to delegates.

In December the Council of the AAAS in a formal resolution expressed its hope that funds would be made available to the National Science Foundation and other appropriate federal agencies to permit them to send selected representatives to international scientific meetings. We hope that in the current session the Congress will approve budget requests for this purpose; last year's refusal was shortsighted economy.—D. W.

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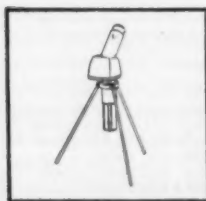
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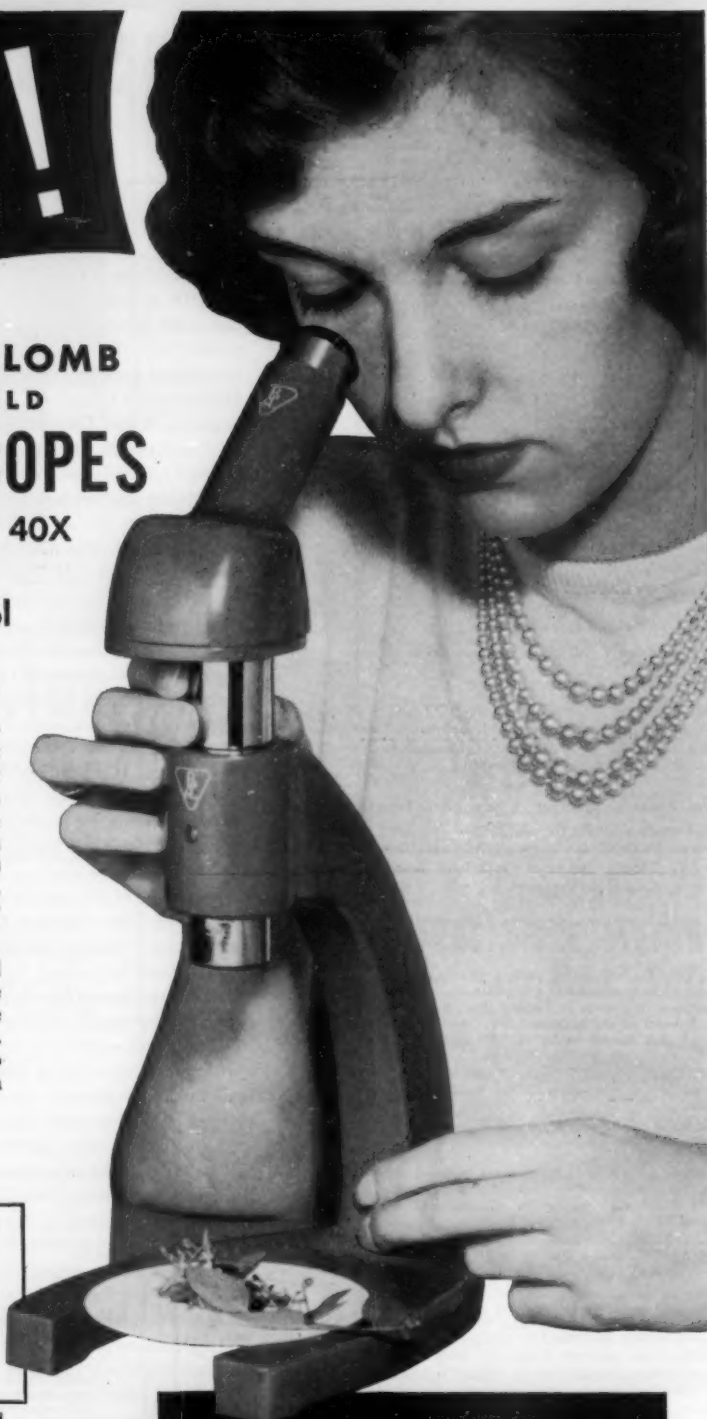
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Edge Waves on the Continental Shelf

Walter Munk, Frank Snodgrass, George Carrier

In 1846, Stokes derived a solution for wave motion over an inclined bank, which differs markedly from the conventional pattern of waves coming onto a sloping beach. In Stokes' solution, the crests are normal to the coast line, and they travel in a direction parallel to the coast. Amplitudes diminish rapidly from the shore seaward and are negligible at a distance of 1 wavelength. Lamb (*1*, p. 447) accordingly calls these waves "edge waves" and states that "it does not appear that the type of motion here referred to is very important." But edge waves appear to be common! Evidence comes from a variety of sources (*2*).

Gust of 6 January 1954

At 3:35 A.M. (0335) on 6 January 1954, an unusual gust was recorded at Scripps pier (Fig. 1). Pressure rose by 2 millibars, and wind speed increased abruptly from 3 to 14 miles per hour. This gust was followed by pressure and wind oscillations of 8-minute period; these have been attributed to internal waves on the atmospheric inversion layer (*3*, *4*). Sea level at Scripps responded to the atmospheric pressure as an inverted barometer. This is shown by the trace of the Scripps tsunami recorder (*5*), an instrument that discriminates by means of pneumatic devices against swell and tides and that has a peak response for a period of 45 minutes. Our attention for the moment is on the

simultaneously recorded (by radio link) signal from the tsunami recorder at Oceanside, 38 kilometers along the coast to the northwest. Between 3:40 A.M. (0340) and 4:50 A.M. (0450), it showed the familiar features of an impulsively generated dispersive wave train. There was no meteorologic disturbance at Oceanside that could account for the recorded wave train.

It is not difficult to compute roughly the character of edge waves that are caused by an impulsive source. Phase velocity C , wavelength L , and period T of edge waves over a beach of constant inclination β are related by the equations

$$C = (gT \sin \beta) / 2\pi, \\ L = (gT^2 \sin \beta) / 2\pi \quad (1)$$

These are identical with the relationships for ordinary deepwater waves when gravity g is replaced by $g \sin \beta$. With this modification, the Cauchy-Poisson treatment of impulsively generated waves in deep water from a line source is applicable. The upper curve in Fig. 2 shows the solution copied from Lamb (*1*, p. 387). Time is in units of $(2y/g \sin \beta)^{1/2}$, and elevation is in units of $Q/\pi y$, where y is the distance from the disturbance and Q is the sectional area of the initially elevated fluid. The second curve is the recorded Oceanside trace corrected roughly for instrument response (on the record, the short late waves are suppressed and slightly delayed relative to the long early waves) and drawn to scale for best agreement with the theoretical curve. Zero time is taken at the first indication of the disturbance at La Jolla. On comparison, we find that

$$(2y/g \sin \beta)^{1/2} = 582 \text{ sec}, Q/\pi y = 0.3 \text{ cm}$$

The mean slope over the continental shelf between La Jolla and Oceanside is 0.02. With this value of $\sin \beta$, we get

$$y = 33 \text{ km}, Q = 3.1 \times 10^9 \text{ cm}^2$$

These values are reasonable; y is nearly the distance between Scripps and Oceanside, and Q corresponds to an initial displacement of 3 centimeters over 10 kilometers. The recorded displacement at La Jolla was about 8 centimeters.

The wave train is barely discernible on a record taken by the Mark IX wave instrument at Camp Pendleton, 3.5 kilometers northwest of Oceanside. With imagination, one can find some traces on tide records in the Los Angeles area. However, these records are hardly useful; the wave instrument is tuned to higher frequencies, and the tide gage is tuned to lower frequencies than the frequency of the disturbance under consideration.

We must point out a number of difficulties in the application of the Cauchy-Poisson theory to our problem. The continental shelf is about 5 kilometers wide, and the assumption of constant slope is tolerable only if $L/2\pi$ is less than 5 kilometers. This is true for the wave that arrived after 4 A.M. (0400), but the first arrival must have extended beyond the shelf, and the theory does not strictly apply.

It has been demonstrated by Ursell (*6*) that the Stokes solution represents only the gravest of an infinite number of possible modes of edge waves. The n 'th mode has n extrema in elevation between shore and open sea, and its velocity and length are given by

$$C = [gT \sin (2n+1)\beta] / 2\pi, \\ L = [gT^2 \sin (2n+1)\beta] / 2\pi \quad (2)$$

This reduces to Eq. 1 for $n=0$. Note that the computed values of y and Q for the first harmonic are 3 times those for the zero mode and that they are inconsistent with observations. Suppose that the initial disturbance is $f(x,y)$, with x pointing seaward and y measured along the coast. If the disturbance is concentrated very near $y=0$, then $f(x,y)$ can be written $g(x) \delta(y)$, where δ is the delta function. The relative amplitudes of the various modes can be found by expanding $g(x)$ in Laguerre polynomials. The predominance of the fundamental mode points to an exponential-like (at least

The authors are on the staff of the Scripps Institution of Oceanography, La Jolla, Calif. Dr. Carrier is on leave of absence from Harvard University.

monotonic) drop off with distance from shore.

The Cauchy-Poisson theory is derived for such a concentrated line source at $y=0$, but holds reasonably well for a finite width provided that the computed wavelengths are larger than this width. The Oceanside signal ended at 4:50 A.M. (0450) with a period of 10 minutes, which corresponds to a wavelength of about 10 kilometers. This may be taken to mean that the initial disturbance was about this wide.

A search through 3 years of records did not reveal any other example of a comparable gust, nor did it reveal a similar Cauchy-Poisson type of disturbance in sea level.

Hurricanes and Squalls

On 26 August 1954, hurricane Carol formed near the Bahamas and was moving very slowly northwestward. On the morning of 30 August, the hurricane started its rapid trip up the East Coast. According to weather maps (7), Carol was moving at 32 knots when it passed Atlantic City 24 hours later. From the arrival times of the water-level disturbance at various tide gages (8), we obtain 34 knots.

Consider the characteristics of edge

waves that might be generated by such a traveling disturbance. The prominent waves will have a velocity C that just equals U , the longshore component of velocity of the traveling disturbance. Precisely the same considerations determine the period and length of waves behind a vessel traveling at velocity U . Accordingly, we replace C by U in Eq. 1 and obtain

$$T = \frac{2\pi U}{g \sin \beta}, \quad L = \frac{2\pi U^2}{g \sin \beta} \quad (3)$$

for the period and wavelength of the fundamental edge-wave "wake." Off Atlantic City, the 30-fathom line is approximately 100 kilometers offshore, giving a slope of $\beta = 5 \times 10^{-4}$. For $U = 32$ to 34 knots, this yields $T = 5.8$ to 6.1 hr for the fundamental mode. A. C. Redfield and A. R. Miller have kindly furnished us values of observed minus predicted tide level. They indicate four waves about 2 feet high with a period of 5.5 hours (Fig. 3). Note that these waves do not show the progressive shortening in period that is so characteristic of impulsive generation (Fig. 2).

For the first harmonic ($n=1$), the computed period is one-third of the fundamental. The records do not show any prominent oscillations of 2-hour period.

Further north, near Sandy Hook, the 30-fathom line is more nearly 120 kilo-

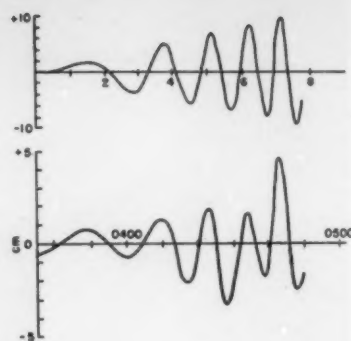


Fig. 2. The upper curve shows elevation against time at a fixed point according to the Cauchy-Poisson theory. The lower curve is the recorded water level at Oceanside corrected for instrument response.

meters offshore, and $\beta = 4.25 \times 10^{-4}$. The computed periods are then somewhat longer, 6.9 to 7.2 hours. The measured period at Sandy Hook was also longer, 7 hours. But it is not clear whether the change in topography actually accounts for the change in period, and we have not considered in detail what happens when slope varies gradually along the travel path.

The wavelengths are of the order of 400 kilometers. Edge waves are essentially confined to a strip within a distance $L/2\pi$ from shore; for this reason, we have based our calculations on average slopes over the first 100 kilometers. Beyond the continental shelf, the slope is far larger. To estimate the effect of this increased slope, we have worked out the theory (not given here) for an inclination β_1 to a distance x_1 , followed by β_2 beyond x_1 . Setting

$$x_1 = 200 \text{ km}, \beta_1 = 4.25 \times 10^{-4}, \beta_2 = 5.9 \times 10^{-3}$$

for the bottom off Sandy Hook leads to a decrease in computed period by roughly 2 percent. The approximation of a constant slope is adequate.

The sea-level disturbance at Atlantic City and Sandy Hook consisted of four waves and lasted until about 24 hours after the passage of the hurricane. A rough calculation of the expected duration of an edge-wave wake is as follows. Hurricane Carol started its rapid trip up the east coast on the morning of 30 August from about latitude 31°N . The hurricane arrived at Atlantic City about 24 hours later. The front of the water disturbance arrives with the hurricane; the rear travels with group velocity, which is one-half the phase velocity for edge waves. Hence the rear will take twice 24 hours, and the duration is 24 hours, as observed. For the general case, let D be

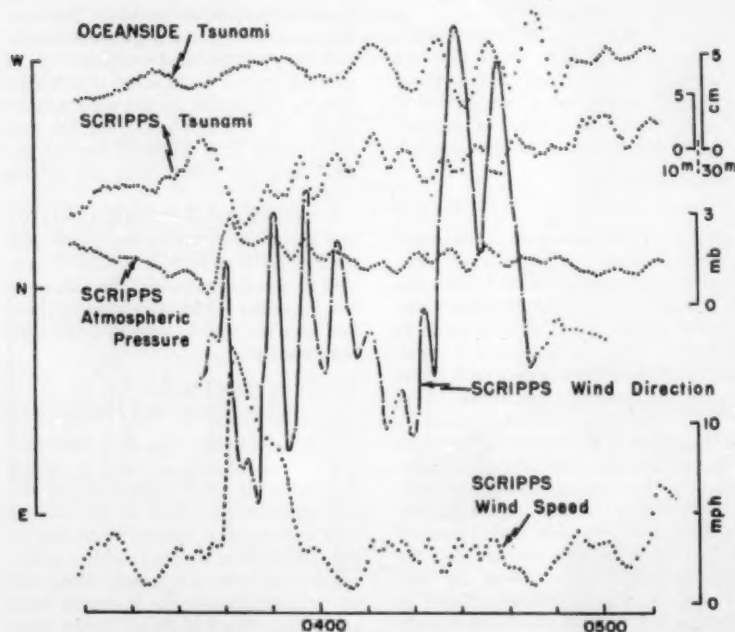


Fig. 1. Meteorologic and sea-level records of 6 January 1954. The Scripps and Oceanside tsunami recorders are peaked for sea-level oscillations of 45-minute period. The scale for oscillations of 30-minute and 10-minute periods is indicated. A gust recorded at Scripps at 3:35 A.M. (0335) is followed by a dispersive sea-level oscillation at Oceanside, 38 kilometers to the northwest.

travel time and Y travel distance at a velocity of U . The duration τ of the disturbance is given by

$$\tau = D \text{ or } \tau = Y/U \quad (4)$$

These expressions are equivalent for constant U , as assumed. For Carol we set $D=24$ hr, $Y=540$ naut. mi., $U=33$ knots; the two expressions give $\tau=24$ hr and $\tau=16$ hr. The numerical values are summarized in Table 1, together with similar calculations for three other hurricanes (9). The values for Edna are similar to those for Carol. The hurricanes of 1938 and 1944 had similar paths and were farther out at sea than the 1954 hurricanes. We have taken their starting time when the storms' centers came over the shelf just south of Cape Hatteras. This yields durations that are considerably shorter than the observed values. To obtain agreement, one must take the starting time 12 hours earlier, when the hurricane centers were about 250 miles from shore.

It is known that the rise in water level is of the same order as that given by the inverse barometer rule: the water level rises 1 centimeter for each millibar of pressure drop. The measured rise is often larger, and the difference is attributed to winds. Here we limit ourselves to the question whether a traveling pressure spot of reasonable dimension could generate edge waves with amplitudes of the order of the inverted barometer. Consider a pressure spot

$$p = p_0 \frac{a(x+a)}{(x+a)^2 + (y-Ut)^2}$$

traveling from $y=-\infty$, $t=-\infty$ with velocity U parallel to the coast. The resemblance to actual hurricanes is poor, but the Fourier transform is simple. The isobars are nonconcentric circles. The pressure deficiency is p_0 at $x=0$, $y=Ut$, and $1/2 p_0$ on a circle of radius a centered at $x=0$, $y=Ut$. It can be shown that the elevation of the sea surface is given to good approximation by

$$2ka(p_0/\rho g)e^{-k(s+a)} \cos k(y-Ut)$$

where $k = g \sin \beta / U^2$ is the wave number ($2\pi/L$) of the fundamental mode of edge

waves traveling with a velocity $C=U$. Only the fundamental mode is generated to the present approximation. This is, of course, a consequence of the assumed pressure pattern, but it is doubtful whether any monotone (nonwiggly) pressure pattern resembling surface isobars of hurricanes would be an effective generator of harmonics. The crest height at the coast line differs from that given by the inverted barometer rule by a factor of $2ka e^{-ka}$. This has a maximum value of $2/e$ for $ka=1$. Thus, with wavelength having been determined by the speed of the hurricane, its effectiveness depends on the hurricane's dimension. The waves are largest when the radius of the half-pressure isobar equals

$$k^{-1} = L/2\pi = U^2/(g \sin \beta)$$

For the hurricanes under consideration here, this equals 30 to 40 miles. The observed half-pressure radius is more like 100 miles, too large for optimum generation. The afore-mentioned values give $ka=2.5$ to 3.0 , and $2ka e^{-ka}=0.41$ to 0.30 . Thus, the inverted barometer rule yields the correct order of magnitude.

The over-all agreement for the four East Coast hurricanes is good. The observed and computed periods agree, and the longest period is associated with the fastest hurricane. Duration and amplitude cause no particular difficulties. The outstanding feature is that the periods are large, and this is attributed to the very gentle bottom slope.

For contrast, we consider very briefly the disturbance caused by a traveling squall over Osaka Bay, Japan, on 29 August 1953 (10). Coming from the southwest at a speed of very roughly 30 knots, it gave rise to a pressure drop of 3 millibars at Wakayama. In this region, the coast tends north-south, and the longshore projection of the velocity was of the order of 40 knots. The offshore topography is irregular. We replace it by an idealized profile consisting of a constant slope to the 30-fathom line 4 miles offshore, and constant depth seaward. The theory for this geometry (not included here) gives a period of 31 min-

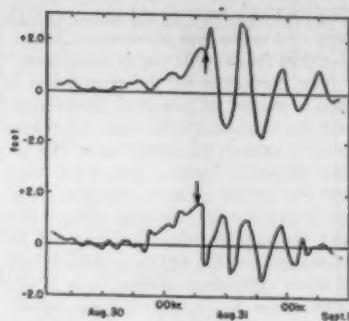


Fig. 3. Observed minus predicted tide-gage level at Atlantic City (lower curve) and Sandy Hook (upper curve) during hurricane Carol. Arrows indicate time of passage of storm center.

utes for a phase velocity of 40 knots. If one assumes the slope to extend indefinitely, Eq. 3 applies, and the period is 29 minutes. The observed periods along this stretch of coast line were 20 minutes at Shimatsu, 30 minutes at Kainan, and 25 minutes at Wakayama.

On comparison with Table 1, we find the velocities of the disturbance to be commensurate, but the bottom slope of Osaka Bay is 15 times larger than that off Atlantic City. In accordance with edge-wave theory, the excited periods should be one-fifteenth as large, and they are. In most regions of the world, the slope is even larger than it is off Wakayama, and the observed open-sea seiche periods are shorter. Typical values are $\beta=0.015$ and $T=10$ min; this requires a longshore component of velocity of 27 knots for the traveling disturbance.

Redfield and Miller (8) discussed the oscillatory wake under the heading "resurgences." They stated "these phenomena are of particular importance because they tend to catch one unaware, coming as they do after the storm appears to be subsiding. . . . Should a storm pass along the coast at low tide the accompanying rise in water level might be inconsequential, but the resurgence occur-

Table 1. Periods and durations of sea-level disturbances caused by four hurricanes.

Hurricane	Velocity U (knots)	Path Y (naut. mi)	Travel time D (hr)	Wave period T (hr)		Duration (hr)			
				Computed		Observed		Computed	
				$\sin \beta = 5.0 \times 10^{-4}$	$\sin \beta = 4.2 \times 10^{-4}$	Atlantic City	Sandy Hook	Atlantic City	Sandy Hook
30 Aug.-1 Sept. 1954 (Carol)	32-34	540	24	5.8-6.1	6.9-7.2	5.5	7.0	16-24	20
11-12 Sept. 1954 (Edna)	32	530	24	5.8	6.9	6.0	7.0	17-24	23
14-15 Sept. 1944	33	360	12	6.0	7.1	5.6	7.2	11-12	23
21-22 Sept. 1938	40	360	9	7.3	8.6		8.0	9	16

ring six hours later would arrive at high tide, and might thus prove more destructive than the original rise in water level."

The prediction of the resurgences is then a matter of practical importance, and our calculations for four hurricanes must be extended to other cases. The results shown in Table 1 give some hope that the arrival time of resurgent crests can be predicted on the basis of Eq. 3 and that the number of such crests can be estimated from Eq. 4. The amplitude will be more difficult to predict; it is of the order given by the inverted barometer rule. We expect resurgences only if the hurricane travels over the shelf for a time exceeding $T [= 2\pi U / (g \sin \beta)]$, Eq. 3]. Hurricane Hazel came over the shelf at 40° incidence and quickly traveled inland. There were no resurgences.

In closing this discussion, we should point out the connection between our treatment and previous investigations. Redfield and Miller (8) contoured the depth h^* for which $(gh^*)^{1/2}$ equals the speed of the disturbance. They correctly emphasized that effective generation of the water-level disturbance takes place only where the shelf depth is less than h^* . Our interpretation of h^* (for constant slope) is the depth at a distance $L/2\pi$ from shore, the mean distance of the wave elevation. Ewing, Press, and Donn (11) drew similar contours to explain the disturbance caused by a squall line over Lake Michigan. They attributed the disastrous wave to the unusually high velocity of the squall. This has the

effect of coupling the atmospheric disturbance to the relatively flat areas near the lake bottom rather than to the steeper edges. Edge-wave theory is not applicable to this situation, but it might be profitable to look for a normal mode solution that is.

Edge-Wave "Noise"

The causes discussed so far have dealt with clear-cut and exceptional meteorological disturbances. But the Scripps and Oceanside tsunami recorders show some activity at all times. The root-mean-square height ranges from less than 1 centimeter on quiet days to more than 5 centimeters on noisy days. There is a correlation between the general level of activity at Scripps and Oceanside, but there is no coherence between individual waves at the two stations. The records are irregular and quite similar in appearance to ordinary wave records, but the periods are about 100 times longer. M. J. Tucker of the National Institute of Oceanography, Great Britain, has kindly made a frequency analysis of some of the records. The spectra show a band of activity between periods of 10 and 30 minutes.

If this activity is the result of edge waves, then it should diminish with distance from shore in the predicted manner. To test this, we have made simultaneous recordings from a shore-based and a ship-based recorder. The portable shore unit was placed on the bottom in about

30 feet of water. The fluctuating pressure acts on a system of capillaries and air volumes that discriminate against swell and tides and give peak response for 10-minute periods. A strain-gage transducer converts the filtered pressure fluctuations into fluctuating voltages, which are transmitted by cable to a bank of shore-based resistance-capacitance filters of very long time constant. Their output is recorded in two broad frequency bands, one centered at 13-minute period, the other at 22-minute period.

This kind of instrument is not readily adapted to great depth. It is hard to provide for an adequate volume of compressed air, and even if one does, one is apt to have a thermometer on one's hand instead of a pressure recorder. We have accordingly abandoned any compliance and prefiltering at depth for the ship-based instrument. A Vibrotan transducer on the sea bottom consists essentially of a stretched wire oscillating at 15,000 to 30,000 cycles per second. The "raw" pressure fluctuations modulate this frequency, and the oscillations are counted and printed on shipboard. The instrument has been used up to depths of 2500 feet. For 1-minute counts, we can detect changes in pressure by 1 millimeter of water.

The Vibrotan output includes the effects of swell and tides as well as the effects of the intermediary frequencies that are under consideration here. For comparison of records with those of the shore-based recorder it is necessary to subject the Vibrotan output to equivalent frequency filters. This has been done numerically by forming a convolution of the record with the Fourier transform of the impedance of the shore-based recorder. Details are elaborate and will be submitted for publication elsewhere.

The observed values in Table 2 have been obtained by the crude method of selecting portions of the record for which some frequency predominates for a few cycles, and then comparing amplitudes and phases. The last columns give theoretical values. The computed ratios in the column headed "edge waves" are $\exp(-2\pi \Delta x / L)$, where Δx is the distance between the recorders projected along a line normal to shore and L is the wavelength of the fundamental mode, $n = 0$, for slopes of 0.02 and 0.03, respectively. The shallow-water values are computed on the assumption that wave heights are proportional to $h^{-1/4}$ and that the phase velocity equals \sqrt{gh} .

For nearby stations, the coherence was sufficiently good to permit positive identification of detailed features on both records, but for shorter periods at distant stations, one ought to compare spectra. The complex submarine topography off La Jolla, Calif. (Fig. 4) is as much a

Table 2. Comparison between selected portions of wave records of ship-based recorder at stated distances and depths and wave records of shore-based recorder at 1200-foot distance from the beach and 22-foot depth beneath mean lower low water; r is the ratio of offshore to near-shore amplitude, and Δt is the offshore minus near-shore arrival time of a coherent feature. For comparison, the values based on edge-wave theory and ordinary shallow-water propagation are also tabulated.

Station	Distance (ft)	Depth (ft)	Observed			Edge wave		Shallow water	
			Period (min)	r	Δt	$\beta = 0.02$	$\beta = 0.03$	r	Δt
A	1,450	35	2	1.0	*	0.39	0.49	0.89	8*
			12.5	0.81	*	0.97	0.98		
			2	0.65	30*	0.00	0.00	0.64	1 ^m 15*
B	4,700	135	3.5	0.65	-40*	0.01	0.04		
			4.0	0.70	-12*	0.02	0.08		
			16	0.85(?)	*	0.79	0.86		
C	6,500	155	3.5	0.56	2 ^m	0.00	0.00	0.61	1 ^m 50*
			4	0.62	-30*	0.00	0.02		
			5	0.50	*	0.03	0.09		
			10.5	0.80	*	0.45	0.56		
D	10,200	295	22.5	0.84	1 ^m	0.83	0.88		
			2	0.37	2 ^m (?)	0.00	0.00	0.52	2 ^m 15*
			13.7	0.50	*	0.44	0.58		
E	22,900	275	2	0.40	†	0.00	0.00	0.53	3 ^m 40*
			12	0.18	*	0.07	0.18		
			15	0.40	*	0.19	0.33		
			22	0.43	*	0.47	0.60		
			25	0.58	*	0.55	0.67		

* The phase lag was too small to be measurable. † No coherence.

liability to us as it is an asset to the submarine geologists. The recorded distances in Table 2 are referred to the beach at Scripps; had we measured them from the nearest land, the values would have been appreciably smaller. We are planning a series of measurements in regions with simpler topography, as well as an analysis involving co- and quadrature spectra of the two records. But even so, certain results stand out clearly from the present crude analysis.

1) There is a marked distinction between waves of period less than 5 minutes and those of period more than 10 minutes.

2) The 2- to 5-minute waves have been called surf beat (12-14). Their spectrum is related to the spectrum of the envelope of the incoming swell, and their energy just outside the surf zone is 1 percent of the wave energy. According to edge-wave theory, these waves should be all but eliminated at stations B, C, D, and E; according to the conventional shallow water theory, the amplitude should be reduced only by a factor of two at the farthest stations. The observed values are certainly not in accord with edge-wave theory. There is rough agreement with regard to amplitudes (but not with regard to phase) with shallow water theory.

3) The 10- to 30-minute waves are believed to be a quite different phenomenon. Certainly their general level of activity is found to be unrelated to that of the surf beat. Table 2 shows that the observed amplitude ratios are in general agreement with those given by edge-wave theory. Particularly at station E, a shift toward the longer periods was noticeable. The shift with distance from shore is analogous to a similar shift with depth in the case of ordinary surface waves.

4) Results were similar at stations B and C, which were located at opposite sides of the Scripps submarine canyon (Fig. 4).

How is the edge-wave noise generated? One is tempted to look again for some coupling between atmosphere and ocean. This time we do not look for a single impulse or a well-defined traveling disturbance, but for the random superposition of many such disturbances. A possible source is the microbarographic oscillations. The microbarograph at Scripps traces a noisy record containing frequencies of the same order as those on the sea-level record. About ten times a year, these oscillations show rather well-defined patterns with amplitudes of as much as 1 millibar. One such case is shown by the pressure and wind direction traces on Fig. 1. There is quite good evidence (3, 4) that these oscillations are the surface (actually bottom) manifestation of

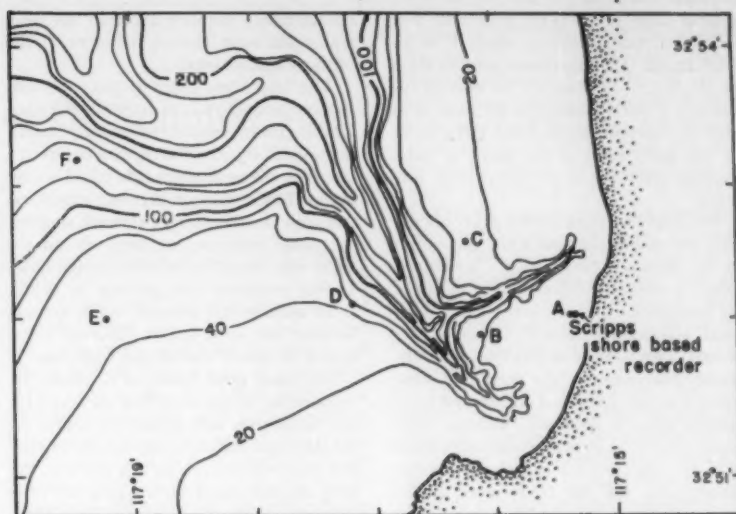


Fig. 4. Depth contours in fathoms off La Jolla, California. Positions of ship-based tsunami stations, A to F. The permanent shore-based recorder is located near station A, as shown.

internal waves traveling on the atmospheric inversion layer with the "shallow water" velocity

$$C_a = (gh_a \Delta \ln \theta)^{1/2} \quad (5)$$

where h_a is the height of the inversion layer, and $\Delta \ln \theta$ is the logarithmic change in potential temperature across this layer. Ultimately, these waves may be caused by a variety of meteorologic events such as cyclogenesis offshore or break-throughs of marine air (4).

We now suppose, without evidence, that the usual microbarographic noise in this area is also the result of internal waves on the inversion layer. Let α be their direction relative to a normal with the coast line. There is coupling with edge waves, provided that $C_a \csc \alpha = C$, or in view of Eqs. 2 and 5, if

$$T = \frac{2\pi(gh_a \Delta \ln \theta)^{1/2}}{g \sin \alpha \sin (2\pi + 1)\beta} \quad (6)$$

Typical values are $h_a = 400$ m, $\Delta \ln \theta = 0.075$, $\sin \beta = 0.02$. For the fundamental mode, these give $\alpha = 90^\circ$ (glancing), $T = 8.7$ min; $\alpha = 60^\circ$, $T = 10.0$ min; $\alpha = 30^\circ$, $T = 17.4$ min; $\alpha = 15^\circ$, $T = 33.5$ min.

The observed values of T are 10 to 30 minutes. The short-period limit of the spectrum is determined by the speed of the atmospheric waves. Longer periods are the results of the "scissors effect" between atmospheric wave crests and the coast line for other than glancing incidence. The computed periods can be made arbitrarily large for near-normal incidence; but for equal probability of wave direction, the spectral densities of very long periods are then very small. Without further measurements, the pe-

culiar mechanism proposed here—that of coupling the atmospheric inversion to the continental shelf—must be regarded as speculation.

Tsunamis

So far, we have dealt with edge waves generated by atmospheric disturbances over the shelf. The reader may have wondered whether tsunamis recorded on coastal tide gages are, at least in part, edge waves excited by long waves from the open sea.

We have considered in some detail the problem of waves from the open sea (depth H_o) impinging on a coastal ledge of some specified width D and depth H_1 . This geometry makes the algebra simple and the comparison with observed conditions difficult. A detailed treatment is out of place here, but we shall sketch our results. Suppose a regular wave train arrives from the open sea with a velocity $C_o = (gH_o)^{1/2}$ from a direction α relative to the coast normal. After a time interval of several wave periods, a disturbance is built up over the shelf. The disturbance is driven along the coast line with a speed $C \csc \alpha$ that is far greater than the speed of free edge waves of comparative length.

The amplitude at the coast line depends on α and the relative dimensions of the shelf and waves. For our simple geometry, Brewster's angle

$$\arctan (C_o/C_1) = \arctan (H_o/H_1)^{1/2}$$

enters in a critical manner. For incidence more nearly glancing than Brewster's angle, the coastal amplitude is always

smaller than the deep-sea amplitude. For incidence more nearly normal, it is always larger. The maximum amplification is $(H_0/H_1)^{1/2}$. This occurs for normal incidence if the wavelengths are such as to give an antinode at the coast and a node at the outer edge of the shelf, in close analogy with the open organ pipe formula.

We must therefore expect that only the first few waves can give some indication of the deep-sea disturbance. Thereafter, selective amplifications of those particular frequencies that are in resonance with local topography should dominate the record. This is more or less what one observes. For example, the measured time interval between the first and second crest usually shows a systematic increase with travel time (15) in accordance with what is to be expected for slightly dispersive waves (16). But the frequencies in the interior of the record differ erratically from station to station. A spectrum analysis by M. J. Tucker of the La Jolla and Oceanside tsunami records for the Japanese tsunami of 4 March 1952 (17) revealed sharp peaks at periods of 30 and 21 minutes. Application of the open organ pipe formula yields resonance amplification of the continental borderland ($H_0 = 3000$ m, $H_1 = 1000$ m, $D = 260$ km) for periods of 1.2 hr, 2.5 hr, and so forth; the continental shelf ($H_0 = 1000$ m, $H_1 = 100$ m, $D = 1.5$ km) is resonant for periods of 3 minutes or less. The former periods are larger, and the latter are smaller than the periods believed to be effectively generated by tsunamis, and this may explain why the average amplitudes in the California region are only a fraction of those at Hawaii. There is no clue here for the observed spectral peaks of 30 and 21 minutes. Our interpretation is that the continental waves are due to

off-resonance coupling and that the spectral peaks were already inherent in the offshore disturbance.

The important point is this: the customary procedure is to estimate deep-sea amplitudes by assuming a coastal amplification of $(H_0/H_1)^{1/2}$ according to Green's law, or some equivalent rule based on ray optics. Since we find that the amplification may be much larger or much smaller, the usual estimates of deep-sea amplitudes may be off by orders of magnitude. Useful estimates can perhaps be made from stations on isolated small islands because the wave height observed there would be nearly that of the open sea.

One more point needs to be made. Irregularities in the coast line such as bays and headlands will scatter the waves on the shelf and convert some of their energy into free edge waves. In this manner, the deep-sea disturbance is trapped into low-velocity propagation along the edges (13). A curvature in the coast line that is concave shoreward (a bay) should be effective in trapping; convex curvature would lead to a loss of trapped energy by radiation back to the open sea. Major tsunamis are followed by something like 5 days of enhanced activity, whereas the sea-level disturbance in an infinite ocean of constant depth should be a matter of hours, at most. Some of the prolongation is undoubtedly associated with reflection from continental borders, as shown by Cochrane and Arthur (18); some may be the result of scatter from oceanic islands and sea mounts. We suggest that some of the afterglow, at least on continental margins, results from a conversion by coastal irregularities of fast open-sea waves into slow edge waves. There is a close analogy here with the experimental demonstration by Tatel (19) that some of the complexity of seismic records can

be traced to a conversion by surface irregularities of fast body waves into slow surface (Rayleigh) waves. But there are difficulties with this suggestion. Travel times between La Jolla and Oceanside for tsunami waves do not check out well; and how is one to account for the afterglow at Hawaii?

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Experiments have two great uses—a use in discovery and verification, and a use in tuition. They were long ago defined as the investigator's language addressed to Nature, to which she sends intelligible replies. These replies, however, usually reach the questioner in whispers too feeble for the public ear. But after the discoverer comes the teacher, whose function is so to exalt and modify the experiments of his predecessor as to render them fit for public presentation.—JOHN TYNDALL, in Six Lectures on Light, Lecture 1.

News of Science

Expanding Universe

The theory of the expansion of the universe rests observationally on Hubble's law, which shows that galaxies in space are receding from each other with velocities that are proportional to their distances apart. Evidence for this red-shift law rests on observations obtained only in the narrow visible portion of the wide electromagnetic radiation spectrum that impinges on the earth's atmosphere.

The observed red shifts of the optical lines have been interpreted as the result of a true recessional velocity, the shift arising through the well-known Doppler effect. Alternate explanations of the red shift have been advanced which would not require motions in the universe; as Finlay Freundlich has proposed, the spectral shift might be the result of a possible photon-photon reaction, whose red shift would depend on the path length and radiation field traversed by the quanta. From debates such as those raised by Freundlich, and because of the importance of the Doppler interpretation in cosmologies, astronomers, cosmologists, and physicists have considered the possibility of additional independent "tests" that would either support or cast doubt on the Doppler interpretation.

Such a test for the Doppler interpretation would be a red-shift measurement on an extragalactic object, using radiation of a wavelength that is significantly different from the optical wavelengths. If the observed red shift is the result of a real recession of extragalactic objects, the wavelength shift divided by the wavelength used should be constant anywhere in the electromagnetic spectrum.

The spectral line at a wavelength of 21 cm, which arises from hydrogen gas in the interstellar medium, offered such a test for the Doppler interpretation. Its detection by Ewen and Purcell at Harvard University in 1951 was one of the most important landmarks in radio astronomy. The emission line at the 21-cm wavelength comes from vast hydrogen clouds that are a part of the Milky Way.

This emission line is caused by a hyperfine transition in ground level of the hydrogen atom. Normally the line appears in emission, and studies of the intensity and Doppler shift by Dutch, Australian, British, and American radio astronomers have led to an enlightened

picture of the dynamics of the Milky Way.

The hydrogen line may also appear as an absorption line if it is viewed against a sufficiently bright background such as a discrete radio source or radio star. The work at the Naval Research Laboratory has been primarily concerned with the absorption effect in the spectra of radio stars and has revealed previously unsuspected fine structure in the distribution of the hydrogen gas in the Milky Way. In addition, it has been possible to determine the distance to a number of the radio sources.

The identification by Baade and Minkowski of the Cygnus A radio source as a pair of colliding galaxies not unlike the Milky Way raised the possibility of detecting the hydrogen gas present in these galaxies in absorption against the hot region where the galaxies are in collisional contact. The two galaxies are at a distance of approximately 100 million light-years and were found by Baade and Minkowski to be receding at a velocity of 16,800 km/sec. If the recessional velocity, or red shift, were real and due to a Doppler shift of the optical emission lines, the same proportional shift would be present in the 21-cm hydrogen absorption line, and it should appear at a longer wavelength.

On this basis the spectrum of Cygnus A was studied by A. E. Lilley and E. F. McClain of the Naval Research Laboratory, and a weak hydrogen absorption line was detected at a wavelength corresponding to a recessional velocity of 16,700 km/sec.

In making the measurements a second nearby radio star Cassiopeia A, was used as a standard against which Cygnus A was compared. This had the effect of increasing the precision of the measurements by an order of magnitude.

With the hydrogen absorption measurements on the Cygnus source, Lilley and McClain have shown the constancy of the red shift over a base-line of 500,000 to 1 in the electromagnetic spectrum. This constancy is a natural consequence of the Doppler interpretation, giving this interpretation strong support. These results now impose the constancy requirement on any alternative explanation. This work was reported at the recent meeting of the AAAS in Atlanta, Ga.

Saltonstall-Kennedy Report

Nearly half of the \$3 million provided for the U.S. Fish and Wildlife Service by the Saltonstall-Kennedy Act for the year ending 30 June 1955 was used for biological research on fish and fisheries, according to a report that has been issued by Acting Secretary of the Interior Clarence A. Davis. A total of \$1,434,000 was expended on these studies. Approximately the same amount—\$1,444,000—was spent for research in the exploration, development, and utilization of our fishery resources. About \$92,000 was allotted to general administrative expenses and \$30,000 to construction.

The Saltonstall-Kennedy Act was passed in 1954, amending existing statutes. It provides funds "to promote the free flow of domestically produced fishery products in commerce by conducting a fishery educational service and fishery technological, biological and related programs—and to develop increased markets for fishery products of domestic origin. . . ."

In carrying out this policy, the Interior Department has let about 60 contracts for research work in every section of the country for more than 40 percent of the year's funds. The contractors include 30 universities, colleges, and public institutions, and 13 commercial and independent scientific research organizations. These contracts represent in excess of \$1,250,000.

More than 100 projects, representing a potential expenditure of more than \$10 million have been suggested for study under the Saltonstall-Kennedy funds. An advisory committee named by the Secretary of the Interior advises in preparing rules and regulations and in recommending priority of projects.

NSF Survey of Industrial Research

Industrial research and development effort in the United States cost \$3.7 billion in 1953 and required the employment of nearly 30 percent of all scientists and engineers in industry, according to a study conducted by the Bureau of Labor Statistics for the National Science Foundation. The report, *Science and Engineering in American Industry—Preliminary Report of a Survey of Research and Development Costs and Personnel in 1953-54*, is based on a questionnaire survey of a sample of approximately 11,600 companies carefully selected as representative of American industry. Alan T. Waterman, director of NSF, says of the report:

"The gratifying response from nearly 90 percent of the companies surveyed shows clearly the increasing emphasis industry is placing on research and de-

velopment. On the basis of this survey, and other studies now under way, we must revise upward to more than \$5 billion the total cost of research and development performed by private industry, educational institutions, Government agencies, and all other types of organizations. Private industry performs roughly two-thirds of all research and development in the natural sciences and engineering. Over one-third of this amount is done for the Federal Government chiefly on contracts with the Department of Defense and the Atomic Energy Commission. However, the survey indicates that only 4 percent—nearly \$150 million—of the total cost of research and development conducted by private industry in 1953 went into basic research."

Electrical equipment and aircraft industries, the survey showed, far exceed all others in the size of their research and development programs. Together, these industries accounted for \$1.5 billion of the 1953 research and development cost.

The chemical industry far surpassed all others in dollars spent for basic research. Nearly as high, however, was the proportion of basic research allocated, out of total research and development expenditures, by the stone, clay, and glass industry group because of the emphasis placed on basic research by many glass companies.

Of the 554,000 scientists and engineers employed by the surveyed industries in January 1954, the largest groups included 409,000 engineers, 60,000 chemists, 11,000 metallurgists, 10,000 life scientists, 10,000 earth scientists, 8,000 physicists, and 6,000 mathematicians. Included, as well, were about 34,000 scientists and engineers classified by their companies as administrators. Of this total, about 157,000 scientists and engineers—nearly 30 percent—were engaged in research and development, including approximately 105,000 engineers, 27,000 chemists, and much smaller numbers in other fields of science.

The survey found that more than 15,000 companies contributed to the nation's research and development effort. Of these, about 13,000, or 85 percent, employed less than 500 persons. Cost figures show, however, that this large group of small companies performed only about one-tenth of all industrial research and development, whereas the 375 largest companies (with 5,000 or more employees) performed about 70 percent. These data are exclusive of enterprises employing less than 8 persons and of individuals working alone, as well as of scientific and engineering consulting firms and a few other types of organizations. Copies of the preliminary report may be obtained from the Superintendent of Documents, Washington 25, D.C., for 30 cents each.

UNESCO Technical Aid Budget

■ UNESCO's technical assistance program will be expanded in 1956. In December, the U.N. General Assembly voted to increase UNESCO's share of the U.N. technical assistance budget from \$3,937,653 to \$4,940,933. A large part of the increase is in the form of national contributions that have in the past proved difficult to utilize because of currency restrictions.

UNESCO plans to have 300 technical assistance experts in the field in 51 nations in 1956. At present, 162 experts are working in 43 countries.

The U.N. finances its technical assistance program by voluntary contributions from member states. The General Assembly this year determined the percentage of the budget that each of the specialized agencies would receive, and UNESCO was allotted 16.6 percent of the total.

Soviet Visitors

Four Soviet medical scientists have arrived in the United States for a 4-week tour to study methods of treatment of poliomyelitis and the preparation of the Salk vaccine. All four of the visitors are from the Academy of Medical Sciences of the U.S.S.R. Members of the group are Mikhail P. Chumakov, director of the Poliomyelitis Research Institute, Marina K. Voroshilova, senior research worker of the Poliomyelitis Institute; Anatolii A. Smorodintsev, director of the department of virology of the Institute of Experimental Medicine; and Lev I. Lukin, scientist of the academy. Arrangements for the tour were made by the U.S. Public Health Service at the request of the Department of State.

The scientists will go to seven cities, including Pittsburgh, where they are scheduled to visit the Municipal Hospital and meet with Jonas Salk. In addition to Washington, D.C., other stops on the schedule include Children's Hospital in Boston, Mass.; Yale University Medical School; the University of Minnesota Medical School; Children's Hospital Research Foundation in Cincinnati, Ohio; Johns Hopkins University; and the National Institutes of Health. The group will be accompanied by Alexis I. Shelokov, virologist for the National Institutes of Health.

New Affiliate of AAAS

The National Society of Professional Engineers was founded in 1934 with a membership of approximately 2500. The four founding state societies—New York, New Jersey, Connecticut, and Pennsyl-

vania—have since then been joined by 35 other state groups, and the national society today includes more than 36,000 members in the United States and its territories.

The membership is limited to engineers who have met the requirements for professional registration as set forth by the laws of a state, territory, or possession of the United States. Organized on a three-level structure—local chapter, state, and national—NSPE gives the individual engineer an opportunity to participate in professional activity and to develop his professional attitudes in terms of service to the community, the state, and the nation.

The society endeavors to raise the standards of the profession in the eyes of the general public, of industrial management, and of engineers themselves. In pursuit of its objectives, the society carries out a broad program of public relations designed to portray the professional engineer's many and important contributions to the American way of life. An important phase of this program is the sponsorship of National Engineers' Week each year, during the week of George Washington's birthday. The events of this week, observed throughout the country, have been highlighted by a congratulatory letter from the President of the United States. During the week, emphasis is focused on engineering activity through the press, radio, television, appearance of engineers before civic organizations, sponsorship of career conferences, and guided industrial tours for students and parents, and similar activities.

The society, in cooperation with the Professional Engineers Conference Board for Industry, carries on a continuing research activity in various phases of engineering-management relationships. A series of Executive Research Surveys has furnished industrial executives with a comprehensive body of material designed to stimulate better use of existing engineering talent. Through its Committee on Engineers in Industry, the society has published a comprehensive volume on engineering-management relationships, focusing attention on existing laws as they affect these relationships and on a number of problems that may be resolved through engineering-management cooperation.

Operating through its national-level committees and implementing activities through similar state and local committees, the society is active in such fields as ethical practices; national defense; vocational guidance; work with young engineers; and the promoting of interest in mathematics and physical sciences in high schools. The society has been active in promoting and improving state registration laws for professional engineers

and has sponsored the publication of a compendium of state engineering laws for all 48 states, the territories of Alaska, Hawaii, Puerto Rico, and the District of Columbia.

The national society publishes a monthly newsletter, a legislative bulletin, and a magazine, the *American Engineer*. In addition, a number of booklets and other printed materials related to society policy statements and engineering information are developed from time to time. The affiliated state societies and local chapters also issue various publications containing items of engineering interest in their areas of activity.

The society has recently built its own headquarters building at 2029 K St., NW, in Washington, financed by the purchase of interest-bearing building bonds by the membership.

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News Briefs

■ The Atomic Energy Commission announced on 12 Jan. that preparations are underway for a series of nuclear tests to begin in the spring at the Eniwetok Proving Grounds. One of the purposes of this series will be the further development of methods of defense against nuclear attack.

Air and sea traffic will be notified through normal channels of the details of the control area well in advance of the commencement of operations. Operations will be conducted by Joint Task Force 7, commanded by Rear Admiral B. Hall Hanlon, USN. Alvin C. Graves, Los Alamos Scientific Laboratory, is deputy commander for scientific matters.

The forthcoming series of tests will involve weapons generally smaller in yield than those tested during the 1954 test series. It is anticipated that the energy release of the largest test will be substantially below that of the maximum 1954 test.

■ In a release on 9 Dec. from the United States Mission to the United Nations, it was announced that the U.S. had appointed Shields Warren, director of the Cancer Research Institute at New England Deaconess Hospital in Boston as its representative on the new scientific committee on radiation effects. Ambassador Lodge at the same time notified Secretary General Hammarskjöld that the alternate U.S. representatives on the committee would be Austin M. Brues, director of the biology and medical research division of Argonne National Laboratory, and Merrill Eisenbud, director of the Health and Safety Laboratory and manager of the New York Op-

erations office of the U.S. Atomic Energy Commission. The new committee was authorized by the U.N. General Assembly on 3 Dec. when it unanimously approved a resolution setting up a Scientific Committee on the Effects of Atomic Radiation.

Warren was the first director of the AEC Division of Biology and Medicine and is now president of the American Board of Pathology. Brues was a member in 1946 of the Brues-Henshaw Investigating Team sent to study casualties at Hiroshima and Nagasaki; he is president of the Radiation Research Society and past president of the American Association for Cancer Research. Eisenbud, who has been associated with the AEC since 1947, has done work on fallout evaluation, radiological hygiene hazards, and beryllium and uranium poisoning. The laboratory he directs is the headquarters for the AEC's National Monitoring System for analysis and evaluation of fallout resulting from nuclear detonations, and he has also undertaken studies of radiological hazards in the civilian atomic energy industry. Both Brues and Eisenbud were listed among the 183 U.S. technical advisers for the Geneva "atoms-for-peace" conference last August.

The U.N. Scientific Committee will be composed of one scientific representative from each of 15 nations, and it is understood that the first meeting will take place in March of this year. The scientific appointees from other nations are not known at this time.

Scientists in the News

JOHANNES IVERSEN, distinguished Danish ecologist, arrived in the United States in December and will remain until June under a grant from the Rockefeller Foundation to encourage the development of pollen analysis here. He is working at the pollen laboratories in the new Willard Gibbs Research Center at Yale University, and is available there for conferences with visitors.

In addition to his profound knowledge of the European Pleistocene, his skill in the critical identification of pollen with modern optical equipment is generously at the service of American palynologists. He is particularly interested in the long Wisconsin and interglacial cores now under study at Yale and at Oberlin, and he expects to attend the pollen conference that is tentatively set for May at the latter institution.

Iversen's plans include an excursion in mid-March to Florida and Texas, and a field trip to the San Augustin Plains in western New Mexico. He has with him films of unusual interest to anthropologists and archeologists that deal with his

research on forest clearance by stone axes and fire for Neolithic agriculture. His mailing address during his visit will be in care of the Yale Conservation Program, New Haven, Conn.—P.B.S.

LEON J. KAMIN, at present a research psychologist at Queen's University, Kingston, Ontario, has been acquitted of a contempt of Congress charge by Federal Judge Bailey Aldrich in proceedings that took place in Boston, Mass. Kamin, who had testified freely about his former affiliation with the Communist Party, was a research assistant at Harvard University until 1 June 1954. His indictment resulted from his refusal to tell a subcommittee of the Senate Committee on Government Operations about former Communist associates "on grounds of conscience."

Judge Aldrich's 24-page decision emphasized that the court failed to accept any of the defendant's contentions that the subcommittee's questioning violated his constitutional rights. The acquittal decision was based on the technicality that the Senate committee had exceeded its authority in its line of investigation.

The judge found that a 1946 legislative reorganization act gave the committee the duty of "studying the operation of Government activities at all levels with a view to determining its economy and efficiency." Aldrich emphasized that Government operation means "the operation of Government departments, not private industry, even though under Government contract." He pointed out that, as established by the Government's own witnesses, the Boston investigation was of "subversion and espionage affecting privately operated defense plants, and this was not within the authority Congress had given the committee."

This decision will undoubtedly have some influence upon the course of the Government's similar contempt proceedings against Wendell H. Furry, associate professor of physics at Harvard University [Science 121, 232 (18 Feb. 1955)].

RAYMUND L. ZWEMER, former chief of the Science Division at the Library of Congress, has been appointed head of UNESCO's Division of International Cooperation for Scientific Research, Natural Sciences Department, Paris. He will be responsible for UNESCO's relations with international scientific unions and other organizations concerned with scientific research on an international scale. The appointment was effective on 30 Dec. 1955.

DAVID A. KEYS, one of the two vice presidents of the National Research Council of Canada (scientific) and the scientific adviser to the president of Atomic Energy of Canada Limited, re-

tired on 3 Jan. Keys obtained his B.A. and M.A. degrees from the University of Toronto, and he received Ph.D. degrees from Cambridge and Harvard universities.

During World War I, he was engaged in antisubmarine research for the Admiralty. During World War II, he was director of the McGill University course that provided more than 2000 radio technicians with their initial training before they went overseas. Later he headed the McGill University Army Course; after the war he was in charge of courses for veterans at McGill.

A member of the physics department at McGill for 25 years from 1922 onward, he did pioneer work in the development of the cathode-ray oscillograph. Later he became known as an expert in geophysics, especially in connection with the use of geophysics in prospecting. A book written by Keys and A. S. Eve on this subject is regarded as a standard text.

In 1945 Keys was named Macdonald professor of physics and chairman of the Physical Science Group, McGill University. In the same year he was also named a member of the National Research Council. In 1947, when NRC was made responsible for Canada's atomic energy work, Keys became vice president (scientific) of NRC and manager of the Atomic Energy Project.

I. S. BOWEN, director of the Palomar and Mount Wilson Observatories, and Nobel laureate HAROLD C. UREY of the Fermi Institute for Nuclear Studies, University of Chicago, were elected honorary fellows of the Indian Academy of Sciences when it met recently in Hyderabad.

ESTELLA F. WARNER has retired as chief of the program development branch of the Division of International Health of the U.S. Public Health Service. Commissioned in 1932, she was the first woman ever commissioned in the PHS.

Her first international assignment was in 1951 when she went to Lebanon to help establish a school of public health at the American University of Beirut. In recognition of her work, the President of Lebanon awarded her the highest decoration that can be given to a civilian. She was the first American and the first woman to receive this award.

Between 1952 and 1955, Warner was stationed in New Delhi, India, where she assisted the Government of India in planning public health technical assistance programs, particularly for rural areas.

Other assignments held by Warner during her 24 years in the Public Health Service include: chief of the Division of State Relations; medical director of the Kansas City regional office; medical consultant of the Chicago regional office;

and regional medical director assigned to the U.S. Bureau of Indian Affairs.

Before entering the Public Health Service, Warner served in state and local health departments in Oregon and was in private practice in Portland. She received her M.D. degree at the University of Oregon School of Medicine in 1918. Warner is leaving Washington to reside in Albuquerque, N.M.

Membership of the technical panel for the earth satellite program has been announced by the U.S. National Committee for the International Geophysical Year. The panel will advise on the development, coordination, and direction of the over-all scientific aspects of the satellite effort.

The members are as follows: R. W. PORTER (chairman), consultant, Communication and Control Equipment, Engineering Services Division, General Electric Company; HUGH ODISHAW (secretary), executive secretary, U.S. National Committee-IGY, National Academy of Sciences; JOSEPH KAPLAN, professor of physics, University of California, Los Angeles, and chairman, U.S. National Committee-IGY, National Academy of Sciences; H. E. NEWELL, JR., acting superintendent, Atmosphere and Astrophysics Division, Naval Research Laboratory; W. H. PICKERING, director, Jet Propulsion Laboratory, California Institute of Technology; A. F. SPILHAUS, dean, Institute of Technology, University of Minnesota; LYMAN SPITZER, JR., professor of astronomy, Princeton University; J. A. VAN ALLEN, head of the department of physics, State University of Iowa; F. L. WHIPPLE, director, Smithsonian Astrophysical Observatory, and chairman of the department of astronomy, Harvard University.

HARRY EAGLE, chief of experimental therapeutics at the National Microbiological Institute, has accepted an invitation from the Stanford University School of Medicine, San Francisco, to deliver the Morris Herzstein course of medical lectures on 12, 14, and 16 Mar. The first two lectures will be on "Specific growth requirements, metabolic activities, and nutritional deficiencies of normal and malignant cells in tissue culture," and the final one will deal with "Nutritional requirements for the propagation of poliomyelitis virus; and observations on the use of tissue culture for the screening of carcinolytic agents."

CARL S. MARVEL, research professor at the Noyes Chemical Laboratory of the University of Illinois and an expert on synthetic polymers, has won the American Chemical Society's Priestley medal for 1956. The gold medal will be

presented to Marvel for "distinguished services to chemistry" during the 129th national meeting of the ACS in Dallas, Tex., in April.

Marvel, president of the society in 1945, directed part of the World War II research on synthetic rubber and also served from 1944 to 1946 as chairman of the National Research Council's Panel on Synthesis of Antimalarial Drugs and as a member of the Board for Coordination of Malaria Studies. He has contributed to the development of plastics of the vinyl polymer type, particularly those used in the production of transparent aircraft pieces, as rubber substitutes, and as thickening and blending agents in the chemical manufacturing industry.

Other research conducted by Marvel was concerned with the development of practical methods for preparing amino acids; synthetic diets employed in intravenous feeding; and the relationship between hydrogen bonding and solubility factors, particularly with respect to improved methods of electrical refrigeration.

LINUS PAULING, chairman of the division of chemistry and chemical engineering, California Institute of Technology, will deliver the second annual Margaret Beattie lecture on 4 Feb. in the St. Francis Hotel in San Francisco. He will discuss "Abnormal hemoglobin molecules in relation to hereditary hemolytic anemia" at a dinner meeting that is an annual event sponsored by the California Association of Clinical Laboratories and the western section of the Council of American Bioanalysts.

MALCOLM GOODRIDGE, a past president of the New York Academy of Medicine and a fellow for 50 years, received the Academy plaque on 7 Jan. in recognition of outstanding service to the academy.

EUGENE F. DuBOIS, formerly professor of physiology and biophysics at Cornell University Medical College, was presented with the Academy medal "In recognition of his fundamental contributions to the science of metabolism and the understanding of disease; of his influence upon the thought and activities of other leaders of medicine; [and] of his accomplishments in the development of clinical science and medical education..."

FELIX E. WORMSER, Assistant Secretary of the Interior, has been named 1956 recipient of the Egleston medal, Columbia University's highest award for "distinguished engineering achievement." The medal will be presented to Wormser on 14 Mar. during a dinner at the Waldorf-Astoria Hotel, New York.

GILBEART H. COLLINGS, professor of soils at Clemson College, has been appointed head of the department of agronomy.

Recent Deaths

P. B. CANDELA, Wofford Heights, Calif.; 49; surgeon who developed a method to determine the blood types of ancient peoples; 5 Jan.

RALPH S. DAMON, Garden City, N.Y.; 58; aeronautical expert; president of Trans World Airlines, New York, N.Y.; member of the National Advisory Committee for Aeronautics; 4 Jan.

EDGAR S. MCFADDEN, College Station, Tex.; 64; agronomist at A. and M. College of Texas; recipient of the John Scott award at the 1955 AAAS annual meeting in Atlanta, Ga.; 5 Jan.

W. ALLEN MESSLER, Rutherford, N.J.; 83; professor of psychology at Fairleigh Dickinson College; 8 Jan.

ZENO P. METCALF, Raleigh, N.C.; 70; professor of zoology at North Carolina State College, Raleigh, from 1912-50; since 1950 resident professor of zoology and entomology; 1950 representative of the Ecological Society of America on the AAAS Council; 7 Jan.

GREENLEAF W. PACKARD, Newton, Mass.; 78; inventor and radio engineer; 8 Jan.

CHARLES PRATT, New York, N.Y.; 63; president emeritus of Pratt Institute, Brooklyn, N.Y.; 7 Jan.

EPHRAIM SHORR, New York, N.Y.; 58; associate professor of medicine at Cornell University Medical School, New York, N.Y.; authority on treatment of shock; 1951-53 representative of the Gerontological Society on the AAAS Council; 6 Jan.

ASA O. WEESE, Norman, Okla.; 70; professor of zoology at the University of Oklahoma; internationally known biogeologist; for many years representative of the Oklahoma Academy of Science on the AAAS Council; 20 Nov.

Grants, Fellowships, and Awards

■ Ten new grants, totaling \$65,807, to American universities and medical centers will augment the program of clinical and laboratory research on vitamins and nutrition of the National Vitamin Foundation, Inc. The foundation gives grants-in-aid for research semiannually throughout the United States and abroad. The new grants became effective on 1 Jan.

■ The Dexter Chemical Corporation has established an award in the history of chemistry amounting initially to \$250. The sum will be accompanied by a scroll.

The division of history of chemistry of the American Chemical Society will administer the new annual award; nominations should be sent to the secretary of the division *not later than 10 Mar.*

The award is to be made on the basis of services that have advanced the history of chemistry in any of the following ways: by publication of an important book or article; by the furtherance of the teaching of the history of chemistry; by contributions to the bibliography of the history of chemistry; or by services over a long period of time that result in the advancement of the history of chemistry.

■ The National Foundation for Infantile Paralysis will continue to offer a limited number of fellowships to provide educational opportunities for health educators who are employed in state departments of education or of health. Applicants must have obtained their bachelor's or higher degree from an accredited institution and have had substantial training in biological science and education or other social sciences. Only those who have had a minimum of 2 years of experience as educators in the field of health will be eligible. United States citizenship and sound health are prerequisites for application.

Work may be undertaken at any school of public health in the United States that offers a graduate program in health education and is approved by the American Public Health Association. It is the responsibility of the candidate to make his own arrangements with the institution for a program of study and field training to supplement his previous background and to prepare him more adequately for the responsibilities of a health educator.

The foundation has also instituted a new fellowship program for surgeons interested in advanced study to prepare themselves for teaching or research in orthopedics. Applicants must have completed requirements for certification by the American Board of Orthopedic Surgery or have had equivalent training. Only United States citizens licensed to practice medicine in this country, in sound health, and under 36 years of age are eligible.

Each candidate must arrange his own program for full-time study and investigation at a center which has been approved by the Council on Medical Education and Hospitals of the American Medical Association for residency training in orthopedic surgery and which is associated with an approved medical school.

In both fellowship programs, appointments will be made for 1 year. Financial benefits will be determined on the basis of individual need as related to marital status and number of dependents. Selec-

tion of candidates to be appointed as fellows will be made on a competitive basis by the National Foundation's Clinical Fellowship Committee.

For consideration in May, applications must be filed *by 1 Mar.*; for review in November, applications must be received by 1 Sept.; and for action in February, by 1 Dec. For further information and application forms, address: Division of Professional Education, National Foundation for Infantile Paralysis, 120 Broadway, New York 5.

■ The John A. Hartford Foundation, Inc., has announced the establishment of the John A. Hartford Memorial Fund in the School of Public Health of Harvard University to support a long-range research program in atherosclerosis and other diseases of the blood vessels and heart. The foundation has agreed to provide \$200,000 annually for a period of several years to "institute, maintain and carry out a program of basic scientific and medical research to determine the causes and the medical or other treatment which will prevent or cure or alleviate human suffering from atherosclerosis and related diseases of the human heart and blood vessels," and for graduate education in this field. The new program of research and graduate education will be carried out primarily in the school's department of nutrition, which is headed by Frederick J. Stare.

■ The Nature Conservancy offers an award of \$500 as an aid to graduate study during the next school year. To be eligible to apply, a student must plan to center his thesis on some aspect of the interrelationship between conservation of nature and the increasing pressure of human population.

Applications must be submitted *by 1 Apr.* Interested persons should consult the detailed announcement that may be obtained by writing to the Nature Conservancy, 4200 22 St. NE, Washington 18, D.C.

■ The Damon Runyon Memorial Fund for Cancer Research ended 1955 with grants totaling \$92,205. The awards for December brought money distributed to date to \$9,540,279. The allocations have been made in 609 grants and 327 fellowships in 205 institutions in 48 states, the District of Columbia, and 16 foreign countries.

In the Laboratories

■ The Atomic Energy Commission has announced that it is planning to ask private industry to submit proposals to supply reactor-grade beryllium metal. These requirements are now met from the pro-

duction of a Government-owned plant at Luckey, Ohio, operated for the AEC by the Brush Beryllium Company.

This month the AEC will invite proposals for supplying up to 100,000 pounds annually over a 5-year period. A 3-month period will be allowed in which to prepare proposals. If acceptable proposals are received from private industry, the Luckey plant will be placed in a standby status.

Prospective suppliers should familiarize themselves with the current status of beryllium metal technology and the present and future market for the metal. In addition to the metal required by the AEC, quantities of beryllium may be required for privately financed projects. The AEC does not intend to provide beryllium for such projects. Further information is contained in a prospectus which may be obtained from the Lockland Area Office, U.S. Atomic Energy Commission, P.O. Box 23, Lockland Branch, Cincinnati 15, Ohio.

■ Under a program that is designed to meet the increasing need for up-to-date information about research and development in Europe, the Armour Research Foundation of Illinois Institute of Technology will establish a European office to provide ideas and techniques of potential value in the American market to a group of 16 participating companies.

■ In 1956 the Armour Research Foundation of Illinois Institute of Technology will mark its 20th year of research activity. As part of this observance, the foundation will focus attention on the role of industrial research in the nation's economy. Highlight of the year will be the sponsorship of the first annual National Industrial Research Conference at the Hotel Sherman in Chicago, Ill., on 18-19 Apr. Some of the nation's leading industrial executives and research leaders will participate in the program.

Miscellaneous

■ The Australian Commonwealth Scientific and Industrial Research Organisation, which is responsible for the initiation and carrying out of research, both fundamental and applied, for the promotion of the industries of Australia, is seeking research scientists. CSIRO has expanded greatly since the war, and now consists of some 30 divisions and sections. Its staff and responsibilities have increased and its annual budget now amounts to more than £4 million (\$9 million).

Its laboratories are well equipped and its work in various fields such as radio astronomy, rain and cloud physics, ion-exchange resins, trace elements, and de-

ficiencies in soil is extensive. Recently it organized an International Wool Textile Research Conference that was attended by some 53 research scientists from overseas countries, including 11 from the United States. At present a number of new projects are being planned.

In the Division of Food Preservation, where work has been going on for many years in biochemistry, bacteriology, and food technology, the necessity has arisen for a new research unit in the biochemistry of muscle. The existing Meat Research Laboratory in Brisbane, Queensland, with which the new unit will be associated, has an extensive program on fundamental and technological problems associated with the chilling and freezing of meat for export purposes, but it is obvious that more basic information is required on the physiological basis of the quality of meat. The unit is to be provided with a new laboratory and the necessary research and technical staff and a suitable leader of the group is being sought.

In the irrigation area of New South Wales, CSIRO has supported a research station at Griffith for many years. The fields of research include soils, hydrology, plant physiology, and nutrition. The agricultural crops produced cover a wide variety of fruits and vegetables, rice, wheat, and animal products. Associated with these agricultural industries are canneries, wineries, and rice mills. The officer-in-charge is resigning shortly and a new appointment of a scientist with experience in one of the fields of research of the Irrigation Research Station at Griffith is planned.

The results of agricultural research, like most research, need interpreting to insure their proper and effective use. For this purpose CSIRO a few years ago established an Agricultural Research Liaison Section. This section publishes a quarterly periodical, *Rural Research in C.S.I.R.O.*, that contains reviews of research by the organization for use by agricultural extension workers. Press articles are prepared, conferences are organized and attended, displays are prepared, and frequent visits are made to research centers to insure that the staff maintains close contact with current work. The liaison section has its own layout and artist specialists, and it has excellent facilities for printing and production in the head office of CSIRO in Melbourne.

Australia's development is requiring more research workers and in connection with this expansion, extra staff members are being sought. The Personnel Placement Section of this issue of *Science* gives some further details.

■ Opportunities for physical scientists, engineers, and technicians, exist in the

Antarctic program planned by the U.S. National Committee for the International Geophysical Year. The U.S. Antarctic program emphasizes the following fields: aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, meteorology, and seismology.

Major geophysical research stations will be established at Little America, in Marie Byrd Land, at the South Geographic Pole, on the Knox Coast, and along the Weddell Sea. Initiation of this program began last year with the site-reconnaissance voyage of the *U.S.S. Atka*. Operation Deepfreeze, currently under way, will establish the Little America station, cache supplies for the interior stations to be set up in the fall of 1956, and explore site possibilities for stations on the Knox Coast and the Weddell Sea.

The scientific program will cover slightly more than 2 years from January 1956 to April 1959. Scientists and technicians will leave the United States about 1 Nov. 1956. Positions are open for either the full period of investigations or for the two periods November 1956-April 1958 and November 1957-April 1959. Approximately 2 months of advance training will be provided prior to departure in problems of research, instrumentation, and operations in the polar regions.

Opportunities are available to candidates at the bachelors, masters, and doctoral levels of training and experience. Scientists, engineers, and technicians with training in physics, geophysics, electronics, or closely allied areas and interests in the fields of study listed here are invited to address inquiries to the National Academy of Sciences, U.S. National Committee for the International Geophysical Year, 2101 Constitution Ave. NW, Washington 25, D.C.

■ The U.S. Civil Service Commission has announced that many vacancies in electronic, mechanical, and aeronautical engineering, electronic science, and physics exist in the naval laboratories and evaluation centers in California. The positions pay from \$5440 to \$11,160 a year.

Professional engineers and scientists are needed for urgent and vital projects in electronic technology, rocketry, guided missiles, underwater ordnance, and many other areas of weapons research and development. Further information may be obtained at many post offices throughout the country by requesting a copy of announcement 12-14-1(55) or by writing directly to the Executive Secretary, Board of U.S. Civil Service Examiners for Scientists and Engineers, 1030 E. Green St., Pasadena 1, Calif. Information may also be obtained from the U.S. Civil Service Commission, Washington 25, D.C.

Reports and Letters

Pronuclear Fusion as Affected by X-rays and by Postirradiation Anaerobiosis

In studies on the modification of the mitotic time schedule in the eggs of *Arbacia punctulata* by exposure of the gametes to x-rays, Henshaw (1) made the remarkable observation that x-irradiation caused no retardation from the time of entrance of the sperm head into the egg through fusion of the pronuclei, although it did affect mitotic processes. Since virtually all biological processes have been shown to be sensitive to radiations to a greater or lesser degree, it seems a priori that x-irradiation should also affect the process of pronuclear fusion, for this is a dynamic process and is not merely the result of chance collision of pronuclei. Even though this situation holds for *Arbacia*, it appears doubtful that it should be general for other organisms.

A test of this was made for eggs of *Ascaris lumbricoides suum* (2). These eggs were chosen because of their highly desirable characteristics for the study of pronuclear fusion phenomena. Cytological observations in this laboratory show that all fertilized eggs taken from the terminal 25 mm of the uteri of *Ascaris* are in the pronuclear stage. On incubation at optimal temperatures, pronuclear fusion begins slowly and continues for 48 hours. The eggs of *Ascaris* thus provide an excellent opportunity for study of the effect of x-rays on the rate of pronuclear fusion. These nuclear events differ greatly from those of the more extensively studied eggs of *Ascaris magalocephala*.

Pronuclei are obscured in the cell by large amounts of dense yolk and other granular material. Visibility in the living eggs was enhanced by two methods, namely, compression of the cells and centrifugation of the cells. Of the various stages observed in pronuclear fusion, the one designated $\frac{1}{4}$ -fused was used as the criterion of fusion. The sum $\frac{1}{4}$ -fused is used to designate that stage in which the male and female pronuclei show early signs of union and in which they begin to lose their isodiametric form; the joining process is detectable along an area of the nuclear membranes of approximately one-fourth the diameter of

the pronuclei. The importance assigned to $\frac{1}{4}$ -fusion is the fact that, once this dynamic process has begun in the normal cell, it proceeds to completion with amazing regularity. If the cell or its constituents have been damaged, one of the earliest and most reliable signs of nuclear damage, which is ultimately reflected in aberrations in cleavage and embryogenesis, is the delay in the early stages of pronuclear fusion.

The cleaning and preparation of the egg stocks, as well as the irradiation procedures, have been described previously (3). Irradiations were carried out with unfiltered 100 kv (peak) x-rays; the dose rate was 12 kr/min.

Figure 1 shows the effect on pronuclear fusion of 24 kr and 240 kr of x-rays. The retardation of pronuclear fusion is evident and parallels the retardation of cell cleavage that has previously been observed (3). Interest in recovery mechanisms in radiation effects has prompted a study of postirradiation treatments calculated to bring about recovery from radiation damage. The effect of one successful type of postirradiation treatment, anaerobiosis, on fusion of pronuclei is reported here. Since *Ascaris* is a facultative anaerobe, it is possible to hold eggs for long periods of time under anaerobiosis without detectable harm to the eggs, even at optimal incubation temperatures. Pronuclear fusion is arrested during anaerobiosis; on aerobic incubation, these processes continue undisturbed in normal, unirradiated cells at the same rate as they do in eggs that have not been subjected to anaerobiosis. Eggs that have been x-irradiated and held anaerobically for a 24-hour period immediately following irradiation, however, show an increased rate of pronuclear fusion when they are subsequently incubated aerobically under optimal conditions. This recovery from radiation damage is shown by a comparison of the two pronuclear-fusion curves for eggs that were treated with x-rays only with the curves for eggs that were treated with x-rays and anaerobiosis (Fig. 1).

Pronuclear fusion in *Ascaris* is, therefore, susceptible to x-irradiation damage, as evidenced by a retardation of the fusion process; and recovery, which is evidenced by an acceleration of the fusion

process in the injured cell, can be brought about by anaerobic treatment following irradiation. Since the pronuclear fusion rate in *Arbacia* is very rapid in comparison with that in *Ascaris*, two possibilities may be suggested for failure to observe retardation from x-irradiation in *Arbacia*: (i) the rapid rate of fusion makes observations of delay difficult at the doses used; (ii) the much longer period required for pronuclear fusion in *Ascaris* would permit a greater opportunity for the effects of x-rays to express themselves.

The mechanism(s) whereby this recovery is achieved are at present not clear, but several observations may be made as follows.

1) There is a limited parallel between the present results and those reported for postirradiation anaerobiosis and KCN treatment of irradiated *Vicia* seeds (4). The work on *Vicia* indicates that oxidative metabolism is necessary for rejoining of radiation-induced chromosome breaks. In the present study, no observable development took place during anaerobiosis either, but afterward, under aerobic incubation, recovery was evident and is attributable to the period of anaerobiosis (or KCN treatment as noted in observation 3). The present study, therefore, carries the problem a step further.

2) The recovery is not due simply to the delay in vital processes that is caused by anaerobiosis, for these same processes can be delayed by lowered postirradiation incubation temperatures. Low temperatures, however, do not foster recovery (3) but actually decrease survival and prolong the net time required for cell cleavage when the eggs are subsequently incubated at optimal temperatures.

3) Evidence from other experimentation (5) indicates that the cytochrome

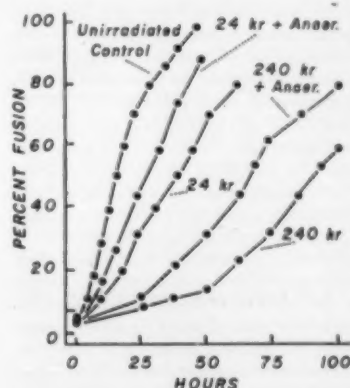


Fig. 1. Effect of x-rays alone and of x-rays followed by 24-hour anaerobiosis on the pronuclear fusion time of the eggs of *Ascaris lumbricoides suum*.

system may be involved, for essentially the same results can be secured by post-irradiation exposure to KCN before the incubation period at optimal temperatures.

4) Since anaerobic recovery is greatest when the deoxygenated eggs are held at optimal temperatures, it appears that anaerobiosis, as well as KCN treatment, functions in some other way than merely by preventing the cytochromes from carrying out oxidative processes that are necessary for the expression of the latent damage in the irradiated cell. While the cytochromes are being held in abeyance, a positive function, probably the anaerobic synthesis of proteins and other substances essential for recovery of the damaged cell, is taking place. The exact nature of these anaerobic recovery processes must await further experimentation.

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22 August 1955

Effect of DDD and Some of Its Derivatives on Plasma 17-OH-Corticosteroids in the Dog

In 1949, Nelson and Woodard (1) reported that 2,2-bis-(para-chlorophenyl)-1,1-dichloroethane (DDD) causes atrophy of the adrenal cortex in the dog. Other workers have confirmed this finding and have obtained indirect evidence of decreased adrenal function following DDD administration (2-4). Recently, Larson *et al.* (5) studied various DDD derivatives in order to determine the relationship of chemical structure to the production of adrenal cortical atrophy or hypertrophy. In the present investigation (6) the effect of DDD, of 2,2-bis-(para-ethylphenyl)-1,1-dichloroethane (Perthane), and of 2-hydroxy, 2,2-bis-(para-chlorophenyl)-1,1-dichloroethane (FW-152) on adrenal function in dogs has been followed as indicated by changes in the plasma 17-hydroxycorticosteroids after injection of ACTH, this response being determined before and after the administration of each of the three compounds. Compound FW-152 differs from DDD and Perthane in that it has been found to produce the histological appearance of adrenal cortical hypertrophy rather than atrophy (5).

Plasma 17-hydroxycorticosteroids were determined by the method of Nelson and Samuels (7). Preliminary experiments revealed that the normal level of circulating 17-hydroxycorticosteroids in dogs is much lower than that found in human beings. In 32 determinations on 9 dogs, the mean level with S.D. was 2.6 ± 1.5 $\mu\text{g}/100$ ml of plasma. Since these values are at the lower limit of accuracy for the method, it was necessary to work with dogs whose adrenals had been stimulated with an intravenous injection of ACTH. Initially, time-response curves were run on several animals, and it was found that the plasma 17-hydroxycorticosteroids reached a maximum level between 1.5 and 2 hours after 20 I.U. of ACTH (8) had been given intravenously. In all subsequent experiments, a control blood sample was drawn, ACTH was given, and a second blood sample was taken at the end of 2 hours. In this way, a 2.5- to 10-fold increase in plasma 17-hydroxycorticosteroids over control levels was obtained; this permitted the measurement of a significant change after the administration of an atrophy-producing compound. Although the range of ACTH response varied among dogs, the response in the individual animal was relatively constant.

In Figs. 1 and 2, the control 17-hydroxycorticosteroid levels after injection of ACTH are represented by a vertical bar that gives the extremes and mean values for three to five tests on each animal. Fig. 1 shows the marked diminution of adrenal responsiveness that occurred after administration of various doses of DDD. Fig. 1A illustrates a fall in plasma levels from 20 to 0 $\mu\text{g}/100$ ml. This animal showed no signs of distress, and after discontinuance of the compound, normal adrenal response to ACTH gradually returned. On subsequent treatment with a

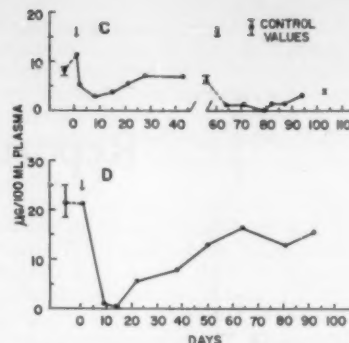


Fig. 2. Effect of Perthane on the level of plasma 17-hydroxycorticosteroids 2 hours after injection of ACTH; \downarrow indicates oral administration of Perthane as a 20-percent solution in corn oil at 200 mg/kg day; X, animal sacrificed.

smaller dose, a similar fall and recovery were noted. A fall in plasma 17-hydroxycorticosteroids to zero was also obtained with several animals that were treated with Perthane, data on two of which are shown in Fig. 2. One animal (Fig. 2C) recovered so slowly after the second treatment with this compound that it was sacrificed at the end of 4 weeks for histopathological study of the adrenals, which showed the typical adrenal cortical atrophy that is produced by Perthane (5). The second dog (Fig. 2D) evidenced a marked sensitivity to Perthane—a single dose produced a fall in plasma 17-hydroxycorticosteroids to zero. Another dog, not shown, was given six doses of Perthane of 200 mg/kg day. On the fifth day, the plasma level was zero, and death occurred on the eighth day.

As is apparent in Figs. 1B and 2C, levels somewhat higher than normal were occasionally obtained 6 hours after the compounds were given. This effect was fleeting and was not consistently found.

Two dogs were treated daily with FW-152 at 50 mg/kg day. At the end of 1 week, one died suddenly of an unknown cause, having shown no significant change in the 17-hydroxycorticosteroid level. The other dog was sacrificed after 26 days, when it was in a moribund state. Because of poor fixation, histological examination was unsatisfactory. During the experimental period, the plasma 17-hydroxycorticosteroids fell slowly from 14 to < 2 $\mu\text{g}/100$ ml, a finding that is of interest in view of the microscopic adrenal changes indicative of hypertrophy that have been previously reported following administration of this compound (5).

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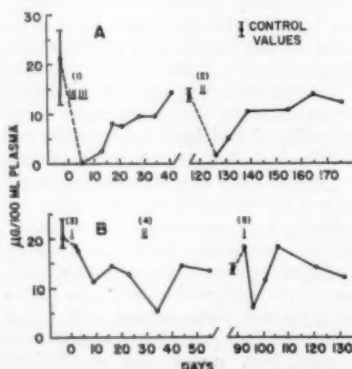


Fig. 1. Effect of DDD on the level of plasma 17-hydroxycorticosteroids 2 hours after injection of ACTH; \downarrow indicates oral administration of DDD as a 20-percent solution in corn oil as follows: 1, 2, 3, and 4—100 mg/kg day; 5—200 mg/kg day.

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22 August 1955

Increased Production of Carotene by Mixed + and - Cultures of *Choanephora cucurbitarum*

The production of carotenoid pigments by filamentous fungi is apparently quite common, but knowledge of their functions in fungus metabolism is meager. There is evidence that β -carotene is concerned with phototropic responses of certain fungi, and in many fungi, visible amounts of carotenoids are produced only in the reproductive structures. Goodwin (1) has reviewed the literature on this subject. *Phycomyces blakesleeana* has been the principal test fungus, and the mycelium of either the + or the - sex (2) has been used. *Choanephora cucurbitarum* is not mentioned as a carotene producer.

Choanephora cucurbitarum is heterothallic (3) and zygospores have been observed and described (4, 5). No mention has been made of carotenoids in the mycelium, and only Wolf (5) reports observing "numerous yellowish oil globules" in immature zygospores.

During routine culturing of *C. cucurbitarum*, it was observed that the mycelium of combined + and - cultures in liquid medium became bright yellow within a few days, while the mycelium of either the + or - sex cultured alone was only slightly yellowish. This paper (6) reports results of subsequent experiments that show that the production of β -carotene by *C. cucurbitarum* is greatly increased in mixed + and - culture.

The + and - cultures of *C. cucurbitarum* used in this study were isolated from the same diseased pumpkin flower at Morgantown, W. Va., in 1954. A liquid medium (glucose, 25 g; acid-hydrolyzed casein, 2 g/lit, essential salts, and thiamine) at an initial pH of 6.0 was used.

The fungus was cultured at 25°C in 250-ml flasks containing 25 ml of medium without agitation and at 28°C in 9-lit bottles containing 6 lit of medium through which sterile air bubbled con-

tinuously. The experiments have been repeated a number of times with similar results, although quantitative carotene determinations were made on only some of the cultures.

Under both sets of cultural conditions, the mycelium in the mixed + and - cultures began to show yellow pigmentation after about 3 days, reaching a maximum intensity about the fifth or sixth day. The + and - mycelia produced little yellow pigment when they were grown separately.

Under all conditions of growth, the mycelium contained much oil after a few days, but only the mycelium in the mixed cultures showed conspicuous yellow pigments in the oil. Later, during sexual reproduction, these pigments usually became concentrated in the suspensor cells that subtend the immature zygospores. Some yellow pigment is evident in the oil droplets in immature zygospores.

The yellow mycelium was squeezed between layers of cloth to remove excess water, and drying was completed with absolute methanol. The pigments were extracted with petroleum ether, saponified and reextracted with petroleum ether. The β -carotene content of each extract was determined by measuring the optical density of 460 m μ in a Beckman photoelectric spectrophotometer according to the procedures of Garton *et al.* (7).

By using chromatographic adsorption techniques (7) and repeated recrystallizations from a 1-to-1 solution of ethanol and petroleum ether (bp 40° to 60°C), it was possible to isolate the primary pigment. This material was characterized by the use of chromatographic adsorption techniques (7), molecular extinction curves and extinction values ($E_{1\text{ cm}}^{1\text{ percent}} = 2400$ at 455 m μ in cyclohexane) (8), and identified as β -carotene. The yields of β -carotene in one typical experiment are presented in Table 1.

Under these conditions, the mycelium grown in mixed + and - cultures produced 15 to 20 times as much β -carotene per gram of mycelium as did that of either sex grown alone. The evidence suggested that the stimulatory substances responsible for the enhanced carotene production were secreted by the mycelium of the opposite sex.

When the + and - mycelia are grown on opposite sides of a cellophane membrane, both mycelia usually show increased pigment production, indicating that the stimulating substances are diffusible through cellophane and that the effect is reciprocal. The failure of these cultures to form zygospores after further incubation is evidence that the mycelium did not penetrate the cellophane.

Increased carotene production by the mycelium in mixed + and - cultures of a fungus does not seem to have been pre-

Table 1. Weight of dry mycelium and β -carotene after 6 days in 6-lit aerated cultures when + and - sexes were grown separately and together.

Culture	Dry mycelium (g)	β -carotene (μ g)	Amt. β -carotene in dry mycelium (μ g/g)
+	25	1,140	45.6
-	22	1,377	62.6
±	18	16,560	920.0

viously reported. Since there is normally no anastomosis between the + and - vegetative hyphae of the Mucorales, which would result in heterocaryotic mycelium, the stimulation in *C. cucurbitarum* must originate as secretions from the mycelium of the opposite sex. These secretions are possibly of the nature of hormones. It seems probable that some relationship exists between the production of carotene and sexual reproduction in *C. cucurbitarum*.

These investigations, as well as others designed to give more information on the role of carotenoids in the fungi and studies particularly concerning the relationship of carotene to sexual reproduction of *C. cucurbitarum*, are being continued.

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12 August 1955

Fate of Radiostromium Fed to Habrobracon Females

Strontium-89 has been of interest to us, not only because it is a biologically important product of nuclear fission, but more specifically because it is the only pure beta-emitting radioisotope with which we have been able to produce pre-

manent sterility in *Habrobracon* feeding experiments (unpublished). This report (1) gives observations on the biological half-life, on the proportionate gross distribution, and on the egg radioactivity after these female braconid wasps have been fed Sr^{90} . The results differ, not only from findings on *Habrobracon* after P^{32} feedings (2), but also from strontium retention studies in vertebrates (3, 4).

Forty virgin females from wild-type stock 33 of *Habrobracon juglandis* [*Microbracon hebetor* (Say)] were starved at least 4 days, and each was weighed on a precision balance (Roller-Smith). They were then fed Sr^{90} citrate in a honey mixture at a level of 227 $\mu\text{g/g}$ of mixture. With the stock solution of citrate available, this level resulted from mixing in equal proportions with honey. After feeding, each wasp was reweighed. Four that had not fed satisfactorily were discarded. Then, in order to obtain a measure of initial radioactivity for each animal, counts per second were obtained using a thin end-window Geiger tube with standard scaler. Subsequent maintenance followed standard practice in our laboratory. All wasps were provisioned with two host larvae (*Ephestia*) per day and maintained in individual Stender dishes at 30°C.

Twelve wasps were chosen at random to be followed in a study of total body radioactivity. The intact wasp (2 by 0.6 mm), periodically immobilized by brief cooling, can be subjected to Geiger-Müller counting. Thus counts per second were obtained for each animal of the sample 12 hours subsequent to feeding. The emissions were counted again at the end of 24 hours and at daily intervals for 11 days. After this time, the wasp radioactivity was barely above background. Figure 1 presents a summary of the results in net counts per second.

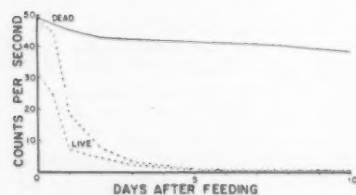


Fig. 1. The relative radioactivity of female *Habrobracon* fed Sr^{90} in honey mixture. The lower broken line represents average radioactivity for nine wasps that ingested the usual quantity, 0.2 to 0.3 mg of the mixture. The upper broken line shows the same for two females that ate 0.5 mg. The solid line, which extrapolates to an adequate representation of typical Sr^{90} decay, is taken to represent this phenomenon as measured in a dead wasp. The female expired shortly after its heavy feeding (0.5 mg).

In view of the physical half-life of 55 days, the biological half-life was achieved in the surprisingly short time of less than 1 day, which indicates very little retention. The dead animal carried for comparison demonstrates the loss in radioactivity owing to isotope decay only (Fig. 1). This picture is quite different from that in vertebrates, in which more than half of a dose may persist after 9 days (4) and in which the rate of elimination can be less than the rate of radioactive decay (5).

A further point brought out by this experiment is that differences in wasp radioactivity following heavy and average feedings are not significant after the biological half-life has been exceeded. Even at the end of the first day, the standard error of the mean for the animals from average feedings is 9.97 counts per second. On the second day, the range of the groups includes the mean value for the high feedings. Ultimately, as is shown by Fig. 1, the curves converge when the means become identical.

The remaining 36 animals were sacrificed in groups of four by transection at the petiole, so that the anteriors and posteriors could be counted separately (sacrifice schedule: days 2, 4, 6, 7, 8, 9, 10, 11, and 12). During the first week after feeding, it was evident that more than 90 percent of the radioactivity that was demonstrable for each female came from the abdomen. Indeed, in the majority of cases, 97 to 99 percent of the radioactivity was shown to be abdominal. In the second week, when radioactivity of the entire animal was barely above background, abdominal radioactivity fell off only slightly. On the 12th day, the abdomens held 86 to 92 percent of total radioactivity. The abdomen contains most of the digestive tract and all the organs of excretion and reproduction.

Eggs laid by the wasps of the transection experiment were collected until the day of sacrifice, and their radioactivity was determined. Eggs laid on the first 3 days were slightly radioactive, an indication that at least some Sr^{90} gets into the physiological interior of fed females. Eggs laid on the third day were barely above background radioactivity. Those laid on subsequent days were not demonstrably radioactive. The average net counts per second per egg were 0.0094 on day 1, 0.0040 on day 2, and 0.0007 on day 3.

When these results were compared with the radioactivity of the ovipositing females, it was found that little more than 0.03 percent of the radioactive material lost from the animal was lost by way of the eggs. This is consistent with the indications from the biological half-life that egestion of feces and excretion plays the important role for this isotope, a

finding quite different from that with P^{32} , where the majority of the fed isotope is incorporated into the eggs and eliminated by this route (2).

These discoveries concerning the fate of radiostrontium explained a perplexity that is met in autoradiographic technique. In direct contrast to the results obtained when autoradiographs are made after radiophosphorus feedings (2), radiostrontium shows up only in the oocytes and not even there if more than 2 days have elapsed since its ingestion. Apparently adult insects have no tissue functionally analogous to bone in a biochemical sense. In vertebrates, the presence of bone with its propensity for fixing the alkaline earth elements is responsible for the retention of strontium. On the other hand, it is well established that the radioactivity of soft tissue of vertebrates is negligible after doses of Sr^{90} (3, 4). Our results are essentially a demonstration of this latter point for an adult insect.

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15 August 1955

Alkaline Phosphatase in Kidneys of Aglomerular Fish

In a recent issue of *Science*, I discussed the implications of the presence of alkaline phosphatase in the aglomerular renal tubule (1). This discussion was based on unpublished observations by Danielli and Lorch and on my own experience with the kidney of *Opsanus tau*. Since the publication of this note, my attention has been called to an earlier paper by Browne and associates (2), who reported the presence of this enzyme in the tubules of a number of teleosts, including three aglomerular species, and in particular, *Opsanus tau*. From their observations, these authors drew essentially the same conclusions about alkaline phosphatase and tubular function as I did. Priority on these points therefore rests with them.

Our conclusions with respect to the significance attached to previous reports of negative results differ. Browne and associates believed that slight variations

of fixing technique probably caused these and thereby apparently closed the matter. However, there are now, including those mentioned in our two papers, sufficient observations from different sources to conclude that kidney tubular alkaline phosphatase may be markedly variable in fish and reptile species. Further work is needed to define the conditions that govern these changes and to determine the consequent functional alterations.

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15 December 1955

Application of Paper Chromatography to Taxonomic Studies

The preliminary work of Buzzati-Traverso and Reznitz (1) suggested that the simple method of squashing fresh tissue on filter paper, followed by one-dimensional chromatographic separation of ninhydrin-positive and ultraviolet-fluorescent substances, could yield results of value in taxonomic and population-genetic studies. These expectations have been amply fulfilled in an extensive investigation of the dipteran family Drosophilidae (2).

The method as previously applied has, however, suffered from limitations imposed by the inadequate separation of complex mixtures that is afforded by one-dimensional chromatography. In *Drosophila melanogaster*, for example, differences between males and females with respect to ninhydrin-positive materials are readily demonstrable by means of two-dimensional chromatography (Figs. 1 and 2). The most striking difference is the presence of a peptide in males that is absent in females, but quantitative differences exist as well (3). When, however, the same solvents are used separately in the development of one-dimensional chromatograms, the differences either fail to be disclosed (in the case of the butanol, acetic acid, and water mixture) or spurious differences are observed (in the case of 80-percent aqueous phenol).

These misleading observations are the result of a number of factors. In the first place, the spots observed on one-dimensional chromatograms frequently consist

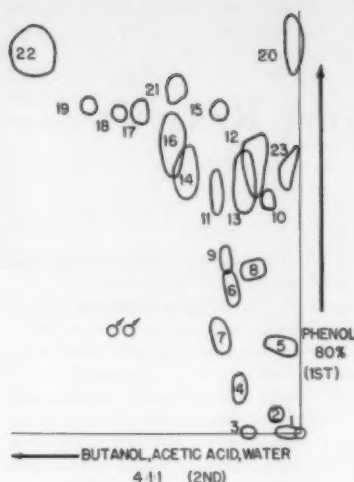


Fig. 1. Two-dimensional chromatogram of free ninhydrin-positive substances in ten decapitated *D. melanogaster* males that were squashed directly on Whatman No. 1 filter paper. First solvent: 80-percent aqueous phenol for 20 hours at 25°C. Second solvent: *n*-butanol, glacial acetic acid, and distilled water (4 to 1 to 1 by volume) for 18 hours at 25°C. Identity of spots: 1, unknown; 2, pupine (?); 3, unknown; 4, aspartic acid; 5, cystine; 6, serine; 7, glutamic acid; 8, taurine; 9, glycine; 10, lysine; 11, threonine; 12, histidine and/or arginine; 13, glutamine; 14, α -alanine; 15, methionine; 16, β -alanine; 17, tryptophan; 18, valine; 19, norvaline; 20, front peptide (?); 21, proline; 22, leucines; 23, sex peptide (specific to males).

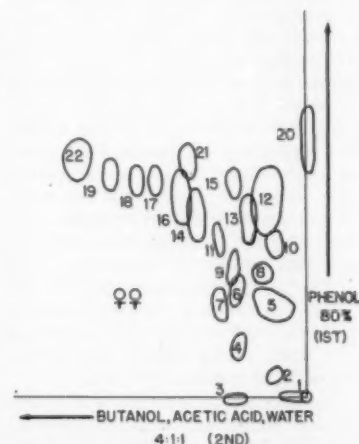


Fig. 2. Two-dimensional chromatogram of free ninhydrin-positive substances in eight decapitated *D. melanogaster* females. Development and identity were the same as in Fig. 1. Note absence of sex peptide, spot 23.

of two or more substances with similar R_f values, and the differences between the sexes are thus obscured. Further, inspection of Figs. 1 and 2 discloses a systematic depression of R_f values in females in the dimension that is developed with phenol. In one-dimensional chromatograms developed with this solvent, this depression of R_f values results in a compaction of spots and an apparent reduction in the number of ninhydrin-positive substances in females as compared with the number in males.

These observations (4) illustrate the obvious advantages of two-dimensional chromatography and suggest its more extensive use in the application of paper chromatography to problems of taxonomy and population genetics. They also suggest that the establishment of the identity of or difference between substances in different species or populations should not depend only on R_f values and such gross observations as color of spots but should also include qualitative identification by means of more extensive chromatographic and chemical procedures whenever possible. Quantitative measurements as well as qualitative identifications would be highly desirable.

Thus, an examination of the distribution of individual, identified substances among species or populations would be preferable to that of over-all chromatographic patterns. As a first approach, hierarchies of chromatographic similarities and differences should be useful in the construction of taxonomic categories, although a more refined approach might be provided by methods of multivariate analysis (5). Properly used, chromatographic methods should come to occupy a position in modern taxonomy similar to that occupied by serologic methods.

A more complete account of the methods of chromatography and identification employed in this work, as well as an analysis of R_f values, will be published elsewhere.

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22 August 1955

Book Reviews

The Unleashing of Evolutionary Thought. Oscar Riddle. Vantage Press, New York, 1954. xxi + 415 pp. \$4.50.

This is a scholarly examination of popular resistance to human self-appraisal on a basis of our accumulated store of verifiable knowledge and insight. The resistance is quickly found to be essentially unrelated to the sharp academic contest between science and theology—a battle already won and ended. The meaningful and enduring warfare is now between a genuinely modern society, still struggling to be born, and the organized religions. Through dominant majorities, in all advanced Western nations, religious tradition and power now suppress or mask vital fact and modern thought concerning the supernatural. Thus no society dedicated to human purposes, rather than to supernatural purposes, can come into existence.

The first six chapters (148 pages) scan, in an orderly sequence, those areas of process and product that tell the reader what evolutionary fact and thought are. Their titles are "From earth-cloud to man," "First principles," "The problem of creation," "Evolution and ethics," "Social inheritance," and "The biological inequality of men." The sixth and longest chapter is especially noteworthy; it can be read with profit by any scientist and by all citizens.

The core of the volume (Part II) is concerned with the extent to which and the means by which, at community and national levels, the religious influence excludes cardinal evolutionary thought from schools, news disseminators, movies and theaters. Emphasis is always placed on conditions now prevailing in the United States, but usually the survey does not end there. Concerning our own high schools, a part of one chapter provides both solid information and incisive comment. In those schools, enforced silence or adroit hedging on the liveliest of all thought on personal and social issues is found to prevail. And this widely predominant circumstance tends to convert schools of still higher and lower levels into "sepulchers of the intellect" and to

involve a covert threat to democracy, social advance and personal attainment.

The concluding chapter, "The broader battle," although it is nonprophetic and not wholly optimistic, is a well-written comment on what seems to lie ahead in this contest of society versus tradition. It is stated that men—or surely those who lead men—will have to make up their minds on how much they care for truth; that many religions render notable services to man at the same time that they frustrate or misdirect the capacity and aspiration of modern man; that mankind's big and grossly unfinished task of self-appraisal is to replace presumed supernatural purposes with definitely human purposes. Oscar Riddle here renders superior service to the human race.

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The Nucleic Acids: Chemistry and Biology. vol. II. Edwin Chargaff and J. N. Davidson, Eds. Academic Press, New York, 1955. xi + 576 pp. Illus. \$14.50.

The first volume of this major compendium in the field of nucleic acids was reviewed in a previous issue of *Science* [122, 248 (1955)]. The second volume has maintained the general level of excellence indicated by the reviewer of the first volume. The first portion of the second volume deals with analytic findings, and the second portion covers the metabolic aspects of the nucleic acids and the smaller components thereof. The volume closes with a chapter on each type of nucleic acid that takes an over-all view of these compounds in the functioning of living systems.

Nucleic acid analysis has been a fashionable occupation in the biochemical world during the past decade. I. Leslie has encompassed and organized in a thoughtful manner the tremendous body of numerical data concerned with the nucleic content of tissues that has arisen during this period. Leslie's discussion of the numerical data is carefully presented

with frequent instances of personal interpretation of seeming disparities or unexpected coincidences in findings by different authors. It is hoped that more future contributors to this field will heed Leslie's comments on the distinction between concentration and content.

The following chapter by Swift is a detailed discussion of recent efforts to extend empirical histological staining methods to qualitative and quantitative analysis for nucleic acids within single cells. This discussion concerns primarily the effect of inherent methodological variables on analytic results. Evidence for the validity of such results is also presented. No effort is made to deal with instrumentation. The contribution of the short histological formulary that is appended to the chapter is of dubious value.

In Chapter 18, Alexander Dounce has reviewed the methods for isolating cell nuclei and nucleoli and has discussed the results of analysis of such isolated organelles. The extensive experience of the author in this field is reflected by the exhaustive detail with which the methods for isolation are described and by the many helpful suggestions that are intercalated. The discussions are phrased in a personal style spiced with numerous expressions of personal conviction.

In the following two chapters, the deoxynucleic acid (DNA) content of the nucleus is reviewed from two particular points of view. R. Vendrely makes a concise presentation of the evidence for the concept of the constancy of the DNA content of the nucleus. It is interesting to compare the viewpoint of this chapter with that expressed in Chapter 27. Vendrely's chapter is followed by a short review and discussion by Bo Thorell of the results of analytic and metabolic studies of the "nucleic acids in chromosomes and mitotic division." The analytic portion closes with a beautifully written and meticulously detailed chapter by Hogeboom and Schneider. The biochemical studies of the morphological components isolated from the cell cytoplasm have played an important part in the formation of current knowledge of the properties of these components and their place in the over-all function of the cell. This literature has been critically reviewed, and the methods for the isolation of the major cellular components are described in sufficient detail to permit one to use the text as a laboratory guide. A relatively small portion of the chapter deals directly with the nucleic acids. Indeed, its organization shows no evidence of preoccupation with this particular field. Its inclusion in the volume is a tribute to the wisdom of the editorial policy.

The next four chapters take up the biosynthesis of the nucleic acids and the small components thereof. Gertrude

Glock has summarized the data on pentoses. She has included a number of helpful metabolic "maps." The difficult work in the field of purine and pyrimidine biosynthesis has been covered by Peter Reichard. The reader is aided considerably in understanding the means by which assignments of the metabolic origin of the atoms of these compounds were made through the inclusion of numerous charts of the degradation methods employed. The next chapter by Fritz Schlenk covers not only the biosynthetic pathways for nucleosides and nucleotides but includes a discussion of the hydrolases as well. The literature is reviewed critically and the important point of the biological origin of the enzymatic preparations is consistently noted.

Brown and Roll have written a superb chapter in which the biochemical literature on the biosynthesis of the nucleic acids is organized on a framework of the biological aspects of these compounds. The detailed numerical data have been pulled together into a single table. These authors are to be commended for the cohesive narrative style in which they review and discuss this involved and rapidly developing area. In the succeeding chapter, Smellie has reviewed the more physiological aspects of nucleic acid metabolism and catabolism. The catabolism of the nitrogenous portions of the nucleic acids is covered in more detail in this chapter than it is in other places in the volume. The literature on the incorporation of phosphorus-32 is usefully summarized in three carefully prepared tables.

The final two chapters are indeed a fitting conclusion to the two volumes. In the first of these, the biological activities of DNA are discussed in an elegant manner by Rollin Hotchkiss. Nowhere have I read a more concise summary of this aspect of DNA than that which concludes this chapter. Brachet wrote the final chapter; he reviews the rapidly growing body of evidence for the role of pentose nucleic acid in protein synthesis, morphogenesis, and plant viruses. Many pieces of evidence are pulled together to evaluate each of the principal hypotheses on these topics. A lengthy addendum brings the reader up to the exciting present.

The documentation of the chapters in this volume is impressive, both with regard to the recency and number of references. One-half to three-quarters of the references are dated 1950 or later. Many references are from 1954. There are from 100 to 300 references per chapter. Relatively few errors were found. There is considerable overlap of subject matter between a number of the chapters, with resultant overlap in references. Few cross references by page are employed.

This volume alone represents a unique work in its field. The two volumes together form an indispensable reference unit; but they are more than that, for they carry the added value of critical consideration and discussion by many leaders in this important field.

JESSE F. SCOTT
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Principles of Animal Virology. F. M. Burnet. Academic Press, New York, 1955. x + 486 pp. \$10.

Burnet's book is certain to be read by a wide group of people who will seek to be informed about those aspects of the subject in which they have interest, but not highly specialized knowledge. I do not believe that they will be disappointed or misled. The book is a very ambitious one in that it seeks to interpret a tremendous range of experimental observations. Burnet is well fitted for this task, for he is a lucid, finished writer with laboratory background, and he has previously carried out some successful smaller operations of this general character. As might be expected, the most stimulating chapters deal with subjects in which the author had vital personal experiences. This applies particularly to those concerned with immune mechanisms, virus variation, and epidemiology. These will provide fascinating reading to those unfamiliar with this field; in addition, they will also be of interest to anyone who attempts to follow the forming outlines in this jigsaw puzzle.

Specialists are bound to carp about points of interpretation relative to their own subjects but probably should not be taken too seriously. However, Burnet is no tyro in the field of poliomyelitis (which is my major interest), so it seems fair to criticize him here. I found the topics chosen for presentation germane but their development occasionally cloudy. For example, it is quite permissible to call attention to the difficulties of understanding poliomyelitis as a disease caused by an exclusively neurotropic virus, but to say that axonal transmission of this virus is a "hypothesis" blurs the subsequent discussion, since it indicates a lack of clear understanding of the many observations on this subject. There were times, also, when I sighed over the omission of some reference to work which to me has seemed important in the development of thinking in this field. One, in particular, was the failure, in the table that details the important animal passage experiments, to mention the adaptation of poliomyelitis virus to rodents by Armstrong in 1939. This discovery furnished a technique that during the suc-

ceeding 10 years made it possible to lay the groundwork for current successes in immunization with inactivated vaccines.

These criticisms need not imply serious faults in the book, but they indicate rather that one should not expect everything. Omissions are inevitable and one great asset of single authorship is a kind of continuity which is missing from the symposium-type books now so numerous in this field. I found that nearly every chapter gave me a good idea. This, I think, achieves the primary aim of the book—to stimulate. The bibliography is also reasonably extensive and should be an invitation to those who would go further.

HOWARD A. HOWE
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Stuttering in Children and Adults. Thirty years of research at the University of Iowa. Wendell Johnson, Ed., assisted by Ralph R. Leutenegger. Univ. of Minnesota Press, Minneapolis, 1955. xviii + 472 pp. \$5.

For a long time there has been a need in the field of speech pathology for a book devoted entirely to researches in the age-old problem of stuttering. Stutterers constitute one of the largest groups of handicapped people in the world. It is estimated that there are 15 million persons who stutter.

This new book contains 43 papers that have resulted from the research program at the State University of Iowa during the last 30 years. Many heretofore unpublished studies are also included.

A great deal of the work centers on the onset of stuttering in children and proposes the theory that the defect begins with the parent rather than with the child. The authors advance the view that stuttering is what the talker does in trying to keep from stuttering again. In other words, Johnson believes that stuttering is a conditioned response resulting from an anxiety to avoid stuttering.

Many of the studies reviewed in this volume deal with interpersonal relationships between personality and stuttering, conditions affecting the severity, variations in the amount of stuttering, and approaches to stuttering therapy.

Part VII is a review of several studies that were formerly available only at the University of Iowa library.

The styling of the volume is excellent. Proper credit and appreciation are given to all the graduate students whose academic labors are so well documented.

I am of the opinion that the total research picture of the Iowa Speech Pathology Laboratories, in order to be complete, should include detailed accounts of

the studies done in the 1920's under the supervision of Samuel Orton and Lee Travis. However, there is a fairly complete bibliographic listing of the many pioneer studies made in the Iowa laboratories during the decade prior to 1931.

Despite the fact that the recorded researches bend in the direction of one point of view, namely a semantogenic interpretation of the problem of stuttering, one cannot help being awed by the number and versatility of the attacks manifested in the diligent labors of the many students who participated in the University of Iowa research program.

The book can well be adapted to courses in "stuttering" now offered by many colleges and universities in this country and abroad.

BRYNG BRYNGELSON
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Origins of Resistance to Toxic Agents.

A symposium. M. G. Sevag, R. D. Reid, and O. E. Reynolds, Eds. Academic Press, New York, 1955. xv + 471 pp. \$12.

This is a remarkable book in that it seems to be lacking in any unifying principle. The papers are connected in a tenuous way by certain key words such as *drug*, in "drug resistance," "drug tolerance," and "drug addiction," and *resistance* in "microbicide resistance," "herbicide resistance," "insecticide resistance," and "resistance to infection." Although the ostensible purpose of the book is to demonstrate that the development of resistance to toxic agents has some common mechanism, regardless of the toxic agent or the organism involved, it actually demonstrates only that the English language is a remarkably flexible device for conducting arguments. Both the papers and the discussions furnish abundant evidence that even well-defined technical words such as *mutation* and *gene* have different meanings for different people.

This book is a continuation of a long-standing dispute regarding the nature and causation of so-called "adaptive modifications" in the properties of microorganisms. The dispute has its basis partly in semantics and partly in strongly held opinions with an intuitive, rather than a logical, foundation. Until these difficulties are resolved, symposia on this topic are unlikely to be useful. The present symposium resembles a major propaganda campaign rather than a serious scientific meeting. Although the book contains a number of excellent and interesting papers, the over-all effect on the reader is distinctly unpleasant. The first section on "Resistance to microbicides" is a repetition of the arguments pre-

sented at the Third Symposium of the Society for General Microbiology in 1953. It simply demonstrates that symposia are not effective in changing opinions. The remaining sections are devoted to herbicides and insecticides, drug and alcohol addiction, various aspects of cancer, and summaries.

An unusual paper by C. P. Martin on "Theories on evolution" deserves comment. The author, who confesses to being an anatomist, discards as untenable the work of all major theorists in the field of evolution from Darwin to Dobzhansky, Mayr and Simpson. The quality of his arguments may be judged by the following quotation: "All the evidence available to us indicates that mutation is a pathological process. All known mutations depress viability and/or fertility to some extent. The existence of a truly favorable mutation is unknown." These statements are incompatible with the evidence presented elsewhere in this volume that acquisition of resistance to chemotherapy is a major clinical problem in the treatment of infectious disease.

A peculiar feature of the book is a number of footnotes that the editor, Sevag, has gratuitously scattered through the volume. On page 93 Sevag and Lam have introduced into the discussion a brief report dealing with replica plating. This report was not presented at the original symposium and the other contributors were not given an opportunity to criticize it. The essence of the report, according to Sevag, is "that results obtained with replica plate test do not offer any proof in regard to the spontaneous origin of drug-resistant mutants. On the contrary, the data strongly support the conclusion that resistance was induced by streptomycin action." Actually the report of Sevag and Lam demonstrates only that these authors failed to comprehend either the experimental or theoretical basis for the replica plate technique of Lederberg and Lederberg. However, Sevag felt that he had destroyed the validity of evidence based on this technique, because footnotes to this effect appear on pages 89, 91, 93, 346, 423, 428 and 429. Also, on page 426 Sevag has added to a discussion by Werner Braun the rather ambiguous footnote "This premise is no longer generally valid. Editors." It seems to me that this is taking unfair advantage of editorial prerogatives.

The longest paper in the book is by Sevag and bears the intriguing title "Protein molecule resistance to microbicides, mutations, and related problems" [sic]. It is impossible in a short review to discuss all the remarkable statements that appear in this paper; however, one sentence is quoted in its entirety without comment. In discussing the effect of sul-

fathiazole on the utilization of tryptophan by staphylococci, Sevag states "It must be noted that, though in the absence of sulfathiazole only 42 percent of the utilized tryptophan cannot be accounted for, in the presence of sulfathiazole this value increased to 259 percent."

The book seems overpriced at \$12.

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Index XIII to the Literature of American Economic Entomology, 1953.

Special Publ. 13. Compiled by Ina L. Hawes. Entomological Society of America, Washington, 1955. 303 pp. \$3.

This book is the latest issue of the well-known bibliographical series, the origin and scope and earlier volumes of which have had previous notice in *Science* [120, 978 (1954)]. It will be welcomed both in entomological research and in control operations for the reason that it now completes and brings down to date an exceedingly useful reference work that reaches back for 95 years and covers American economic literature from 1860 down to the present time. It will be remembered that it was the urgency of the need for a work of this kind that prompted the beginning of the compilation by B. Pickman Mann and Samuel Henshaw and its continuation by Nathan Banks. The original compilation consisted of 8 volumes and covered the years 1860 to 1905 and was published under authorization of the Congress.

The 13 volumes subsequent to that period have been prepared by Nathan Banks, Mabel Colcord, and Ina L. Hawes, who have been assisted at various times by other interested workers. Beginning with *Index VII*, it became necessary to enlarge the geographical scope of the series to comprise continental North America, including Canada, Alaska, Mexico, the Canal Zone, Cuba, Puerto Rico, Hawaii, and certain other Pacific islands, particularly those that played a part in World War II.

This index covers in minute detail a field of research not fully or adequately covered elsewhere; therefore it would be a matter of difficulty to attempt to evaluate its great, outstanding usefulness to the research workers within the scope of its subject matter. This would be particularly true with regard to keeping up with the most recent periodical literature dealing with up-to-the-minute work on such subjects as the newer insecticides, the latest approved methods for their application, or, perhaps, on the latest results obtained from tests of new compounds,

and the like. Indeed, so rapid have been developments along some of these lines that it becomes of deep interest merely to note from one of these something of the extent to which investigation has been broadened from volume to volume in the use of new words that represent names of new compounds, new subject headings, and new types of equipment—additions to the vocabulary that represent definite milestones in the advancement of our knowledge. On the whole, this book represents an exceedingly helpful addition to a series that makes more readily available the literature on control of our insect enemies—enemies that are of sufficient importance that they affect vitally the geographical distribution, the food supply, and the health and general welfare of millions of human beings all over the world.

J. S. WADE

Washington, D.C.

The Metallurgy of Zirconium. Benjamin Lustman and Frank Kerze, Jr., Eds. McGraw-Hill, New York, 1955. xviii + 776 pp. \$10.

Although much has been written about elemental zirconium over the years, one would be led to the belief that it has had wide usage in nonnuclear associated applications. Actually, the only tonnage use of zirconium that has materialized is a consequence of the U.S. Atomic Energy Commission's drive for low-hafnium zirconium as a cladding for fuel elements.

In view of the foregoing, it is refreshing that the first chapter of this book deals with zirconium in its nuclear reactor applications and that the matter of minerals containing the element, reserves and potential reserves, is not presented first as is so customary. Although some of the information contained in the book has been published, it is extremely helpful to get all of the available information between one set of covers, particularly since the authors carefully cross-checked references of the Technical Information Service, which sometimes are not covered completely. Because of this comprehensive coverage, not only are Lustman and Kerze to be complimented, but the contributing authors should be recognized as having done a very good job.

There is no intent whatsoever to detract from the great contributions made by Kroll. However, it is an error to credit him with an entire process from zircon through low-hafnium ingot, as is done on page 71. This does not do proper justice to the very important and excellent work done by the personnel of the Y-12 plant on the zirconium-hafnium separation process, and it is hoped that in future

editions a bit more editorial care will be exercised on this rather minor matter.

Although there is much more to be found out about the metal zirconium and its alloys, there is reason to believe that this book represents a job so well done that it will serve as a bible for those who have to plan in this area.

STEPHEN F. URBAN

*Titanium Alloy Mfg. Division,
National Lead Company*

New Books

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Mass-Transfer Operations. Robert E. Treybal. McGraw-Hill, New York, 1955. 666 pp. \$9.50.

Glossary of Packaging Terms. Standard definitions of trade terms commonly used in packaging. Packaging Inst., New York 17, ed. 2, 1955. 323 pp. \$6.75.

Stories of Scientific Imagination. Joseph Gallant, Ed. Oxford, New York 3, 1954. 152 pp. Paper, \$0.50; cloth, \$0.85.

Essays in Today's Science. Joseph Gallant, Ed. Oxford, New York, 1955. 150 pp. Paper, \$0.50; cloth, \$0.85.

Principles and Problems in Energetics. J. N. Brønsted. Trans. by R. P. Bell. Interscience, New York-London, 1955. 119 pp. \$3.50.

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Progress in Organic Chemistry. vol. 3. J. W. Cook, Ed. Academic Press, New York; Butterworths, London, 1955. 273 pp. \$7.80.

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The Common Sense of the Exact Sciences. William Kingdon Clifford. Edited and with a preface by Karl Pearson. Newly edited with an introduction by James R. Newman. Dover, New York (unabridged and unaltered republication of the Knopf, ed., 1946), 1955. 249 pp. Paper, \$1.60.

Matter and Light: The New Physics. A survey of the contributions of Heisenberg, Compton, Einstein, Fermi, Bohr, Dirac, Planck, etc. Louis de Broglie. Trans. by W. H. Johnston. Dover, New York (original ed., *Matère et Lumière*, 1937; English ed. 1, Norton, New York, 1939), 1955. 300 pp. Paper, \$1.60.

The Windward Road. Adventures of a naturalist on remote Caribbean shores. Archie Carr. Knopf, New York, 1956. 258 pp. \$4.50.

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The Republic of Indonesia. Dorothy Woodman. Philosophical Library, New York, 1955. 444 pp. \$6.

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Chemistry and Human Health. Burnham S. Walker, Isaac Asimov, and M. Kolaya Nicholas. Blakiston Div., McGraw-Hill, New York, 1956. 445 pp. \$5.75.

Dictionary of American Maxims. David Kin, Ed.; introduction by J. Donald Adams. Philosophical Library, New York, 1955. 597 pp. \$7.50.

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(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

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Children's Body Measurements for Planning and Equipping School. A handbook for school officials and architects. Special Publ. No. 4. W. Edgar Martin. U.S. Office of Education, Washington 25, 1955 (Order from Supt. of Documents, GPO, Washington 25). 113 pp. \$0.50.

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Additions to Virginia Mineral Localities. Bull. Eng. Expt. Sta. Ser. No. 105. Richard V. Dietrich. Virginia Polytechnic Inst., Blacksburg, 1955. 30 pp.

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Scientific Meetings

Enzymes as Biological Units

There can be few better bargains in research-foundation investments than those meetings that bring specialists into communication at the intersections of knowledge. The fourth Henry Ford Hospital Symposium, in the arrangement of which staff members of the Edsel B. Ford Institute took a very active part, was held in Detroit from 1 to 3 Nov. 1955 under the title *Enzymes: Units of Biological Structure and Function*. This meeting provided, in the scope of its program and in its distinguished attendance, an admirable setting for the most ambitious attempt that has so far been made to explore aspects of enzyme research that bear on problems in cell physiology. The proceedings of the symposium will be published by Academic Press.

Some 550 persons attended the symposium, of whom 42 participated in the formal program. The goals of the symposium were formulated by Bernard Davis (New York University), who opened the scientific sessions. Davis pictured current studies of isolated enzymes as so successful that traditional enzymology is now rapidly consuming its own substrate. In contrast, enzymatic approaches to the larger events of genetics and cell physiology are in their infancy; these newer aspects of enzyme studies comprised the major theme of the meeting. In this report, the papers that were presented are reviewed under the headings of the six sessions that composed the 3-day symposium period.

Origin of enzymes. The first session dealt with enzyme formation and the relationship between nucleic acids and protein fabrication. Jacques Monod (Pasteur Institute) described evidence for the existence in *Escherichia coli* of a specific inducible system that can concentrate the inducer intracellularly. Although this transport system and the enzyme, β -galactosidase, can both be induced by the same galactosides, the two mechanisms can be clearly separated in mutants with the capacity to form one or the other system independently.

Another aspect of protein synthesis was developed by Ernest Gale (Cambridge University), whose work dealt with sonically disrupted cells of *Staphylococcus*

aureus. Ribonucleic acid (RNA) was required for the synthesis of catalase, as was demonstrated after removal of endogenous RNA with ribonuclease; significantly, only homologous RNA from staphylococci was effective. In contrast to this constitutive enzyme, the formation of an induced enzyme such as β -galactosidase required the addition not of preformed RNA but of purine and pyrimidine bases. Gale's data also suggested a possible role for deoxyribonucleic acid (DNA) in reactivating enzyme synthesis.

S. Spiegelman (University of Illinois) also considered the relationship of nucleic acids to protein synthesis, after he had reviewed data that favor the formation of proteins by simultaneous assembly from a free amino acid pool. Spiegelman, considering the alternative template structures as either DNA or RNA, presented data comparing the relative effects of deoxyribonuclease and ribonuclease on enzyme synthesis. Altered cells, used to permit the access of nucleases, were *Bacillus megatherium* protoplasts—that is, bacteria stripped of their cell walls by the action of lysozyme. Such preparations show inhibition of protein synthesis by partial RNA removal but not by almost complete DNA removal.

The enigma of cell differentiation was the subject of a general introduction by Boris Ephrussi (University of Paris). Although many of the fundamental questions in this area have not been dealt with experimentally, Ephrussi referred to recent observations by Briggs and King on the effect of nuclear transplantation at various stages of differentiation. While the cytoplasm has generally been considered to be the seat of the hereditary changes of differentiation, this work opens the possibility that these changes may depend on alterations, too subtle for cytologic detection, of the nuclear genes.

In the formal commentary following these papers, Melvin Cohn (Washington University) reported that, in *Escherichia coli*, glucose fails to inhibit completely the induction of β -galactosidase if the inducing galactoside is permitted to act on cells for a few minutes before glucose addition; when glucose and the inducer are added simultaneously, essentially no enzyme synthesis is observed. This phenomenon could involve the inducible

concentrating mechanism that was studied by Monod in the same system. The second commentator of this session, Sidney Velick (Washington University), referred to studies indicating that in mammalian muscle also proteins are fabricated directly from an amino acid pool.

Gene-enzyme relationship. The second session was begun by A. D. Hershey (Carnegie Institution, Cold Spring Harbor), who provided evidence that phage DNA can be synthesized under conditions that prevent the formation of phage protein.

Rollin Hotchkiss (Rockefeller Institute) reviewed some provocative features of the phenomenon of inheritable transformations in pneumococci by DNA. In particular, he presented evidence for the linked introduction of different characters and a discussion of possible mechanisms by which transforming DNA is inserted into the genetic material of the recipient cell.

The commentator following, M. Demerec (Carnegie Institution), presented fresh experimental information of possibly far-reaching significance. In *Salmonella*, the successive reactions of histidine biosynthesis match a corresponding linear arrangement of the gene loci concerned with each enzymatic step. Certain other metabolic sequences in microorganisms, however, have failed to show this linear array of the genes for related functions. Demerec also reported that in *Salmonella* a genetic alteration affecting the synthesis of a given enzyme can occur at any of a large number of positions, distinguished from each other by recombination, within the locus of a single functional genetic unit.

Citing the particulars of earlier criticisms, Norman Horowitz (California Institute of Technology) reviewed the history and status of the one gene-one enzyme hypothesis, which should perhaps more accurately be called the multiple gene-one enzyme hypothesis. More specifically, Horowitz discussed the genetic determination of a qualitative enzyme alteration that affects the heat-lability of tyrosinase in *Neurospora*.

The final paper of this session, by Charles Yanofsky (Western Reserve University), exemplified the power of combined genetic, immunologic, and enzymatic analysis in clarifying complex relationships between suppressor genes and a gene locus controlling tryptophan synthetase formation in *Neurospora*. Genetic differences in a series of otherwise indistinguishable mutants were first indicated by qualitatively different responses to a group of suppressor genes. Further investigation of extracts revealed that certain tryptophan auxotrophs possess an enzymatically inactive protein that resembles active tryptophan synthetase in solubility behavior and serologic properties. The

immunologically related protein may be converted to active enzyme in the presence of effective suppressor genes.

The final formal speaker of this session, Joshua Lederberg (University of Wisconsin), ranged over the papers of both previous sessions, descended on factually infirm or logically attenuated assertions, and generally set a high standard of discrimination and clarity for other scheduled commentators.

Enzymes and cell structure. For much of the audience, the most novel material of the symposium was presented in this session, which dealt with the detailed internal structure of the cell. Here the potentialities of electron microscopy, cytochemistry, and cell fractionation methods were revealed, together with their prospect of returning morphology to its former eminence in biology.

George Palade (Rockefeller Institute) surveyed current information concerning cellular structures. A series of remarkably detailed electron micrographs revealed the intricate pattern of intramitochondrial architecture, nuclear membrane structure, and endoplasmic reticulum—the pervasive fabric of vesicles and tubules that occupy the hyaloplasm.

Following the introduction of the mitochondrion as a morphologic unit, subsequent papers dealt with aspects of its physiology. Albert Lehninger (Johns Hopkins University) discussed mitochondria as units that are capable of carrying out many coordinated biochemical functions, among them oxidative phosphorylation. Oxidative phosphorylation as the primary site of action of thyroid hormones has been postulated for some time, for there is direct evidence for the *in vitro* uncoupling of oxygen uptake from phosphate esterification in the presence of thyroxine. Lehninger reported, however, that mitochondrial fractions could be obtained in which thyroxine, in contrast to dicumarol and 2,4-dinitrophenol, no longer uncoupled oxidative phosphorylation. Furthermore, thyroxine promoted water imbibition by isolated mitochondria. Lehninger therefore proposed that thyroxine action may not be directly via one of the reactions of coupled phosphorylation but primarily on the mitochondrial membrane.

Edward Kuff and George Hogeboom (National Institutes of Health) described physical techniques for measuring and fractionating distributions of particles that were derived from tissue homogenates by ultracentrifugation through a density gradient.

Following a comment by Van Potter (University of Wisconsin) on the barriers to communication between the biological specialties, Daniel Mazia (University of California) described experiments with amoebas that were designed to explore nuclear-cytoplasmic interrela-

tionships. The technique of nucleus transplantation was used to show that RNA can be transferred from nucleus to cytoplasm, but not vice versa. In addition, the introduction of a label into the DNA of plant chromosomes revealed occasional instances of unequal segregation of label into daughter cells at mitosis: this result excludes certain possible models of DNA replication.

Daniel Arnon (University of California) reviewed recent work of his group on the reactions of photosynthesis as catalyzed by isolated whole chloroplasts and by broken chloroplast preparations. These preparations carry out not only the familiar Hill reaction but also the reactions of photosynthetic phosphorylation and photosynthetic CO_2 fixation. Light-dependent phosphorylation can be made independent of molecular oxygen by adding certain cofactors and is therefore pictured as utilizing rather directly the energy of recombination of photolysis products. The scheme presented also defines the liberation of O_2 as a process secondary to CO_2 fixation rather than as the direct product of photolysis.

Enzymatic basis of some physiologic functions. W. Mommaerts (Western Reserve University) reviewed some problems in the physiologic significance of the actomyosin-ATP reaction and described an assay system that is capable of sensitive responses to many variables influencing the hydrolysis of ATP by myosin. Manuel Morales (Naval Medical Center) presented arguments that oppose the contention that there is an immediate dependence of myosin contraction on the hydrolysis of ATP. An alternative hypothesis links the contraction of myosin to an association with intact ATP, following which hydrolysis occurs.

An area far less thoroughly investigated from an enzymatic viewpoint is the renal control of specific secretion and reabsorption of plasma components in the formation of urine. John Taggart (Columbia University) presented an interesting analysis of the stimulation by acetate of β -amino hippurate concentration by kidney slices. This effect appears to result not from a direct role of acetate or acetyl coenzyme A but rather from the formation of acetyl glycine. The latter compound is formed at the expense of other acylglycines which, if present, would competitively inhibit β -amino hippurate transport.

Gilbert Mudge (Johns Hopkins University), in discussing the papers presented, made some observations on the properties required of active transport systems and emphasized our fundamental ignorance of these mechanisms.

Among the more successful applications of enzymatic analysis to major physiologic problems, the emergence of

a chemical theory of retinal vision ranks high. George Wald (Harvard University), to whose efforts much of this success is due, presented a concise résumé of the status of the rhodopsin-retinene system, together with some rather suggestive speculations concerning certain recent observations, such as the requirement of a relatively strained and unstable geometric isomer of vitamin A for rhodopsin synthesis and its conversion to another isomer in the course of rhodopsin bleaching. Although considerable enzymatic detail is known concerning the cyclic bleaching and reconstitution of the retinal pigments, Wald emphasized that these reactions are only peripheral to the crucial question of the transduction of light energy to nerve impulses in the optic nerve.

William McElroy (Johns Hopkins University) surveyed the reactions that are known to be involved in the bioluminescence of the luciferin-luciferase system of the firefly and *Cypridina*, as well as recent work on bacterial luminescence. The firefly reactions are complex, involving postulated inhibitors and counter inhibitors. In a final comment on the photobiochemical papers of this session, Bernard Strehler (University of Chicago) reported his recent observation that briefly illuminated green plant material emits light whose spectrum seems compatible with an excited state of chlorophyll or a flavin semiquinone.

Cellular energy sources. Biochemists and general physiologists have long been concerned with electron transfer to oxygen through the chain of respiratory enzymes and the utilization of energy released by these reactions. Elmer Stotz (University of Rochester) reviewed recent methods developed by his group for the purification from heart muscle of several components of the cytochrome system and presented characterizations of the distinct hemes.

Recent advances in the purification of succinic dehydrogenase from beef heart were described by Thomas Singer (Edsel Ford Institute for Medical Research). The enzyme appears to be a flavoprotein containing four atoms of nonheme iron per mole. The flavin-containing fragment, liberated by proteolysis, behaves differently from flavin adenine dinucleotide (FAD) or flavin mononucleotide; Singer considers this fragment as FAD bound to a peptide.

Eric Ball (Harvard University) discussed the nomenclature of preparations of succinic dehydrogenase and problems arising from the fact that the preparations of three groups of investigators differ in their requirement for certain dyes as electron acceptors.

Two papers representing complementary approaches to the physiology of electron transport were presented by

Britton Chance (University of Pennsylvania) and David Green (University of Wisconsin). Chance's work concerned spectrophotometric observations on components of the intact system in isolated mitochondria. Such observations have the unique value of permitting quantitative estimates of major components under quasi-physiological conditions. Green described successive fractionation of mitochondria into fragments that carried out increasingly limited series of reactions in the over-all chain.

Some speculations concerning the role of heme proteins in bacterial photosynthesis were registered by Martin Kamen (Washington University). A comprehensive study of the cytochrome compounds of photosynthetic bacteria having revealed considerable differences from their mammalian counterparts, theoretical account must be taken of the function of these compounds in bacteria that photosynthesize as obligate anaerobes. Kamen proposed that these heme proteins are obligatory intermediates in chemical conversions by light quanta. In anaerobes, cytochrome photooxidases couple electron transfer to the oxidized photolytic product, [OH]; in facultative aerobes, either oxygen or the photolysis product may be the ultimate electron acceptor. The photosynthetic release of oxygen may also be mediated through bacterial cytochrome compounds.

Regulation of enzyme activity. Bernard Davis (New York University) discussed the physiologic implications of selective transport across cellular and subcellular membranes and presented some examples of the use of microbes to study such problems. The ability of certain bacteria to take up citrate was found to be adaptive, and this adaptation was inhibited by glucose—an observation that is strikingly parallel to the work reported by Monod on the uptake of inducers of β -galactosidase synthesis. Evidence was presented that these cases, and similar ones involving amino acids, are based on osmotic work performed by specific enzymelike mechanisms in the membrane rather than on stoichiometric fixation of the concentrated material at intracellular sites.

The direct medical applicability of certain of the symposium topics was apparent in the discussions of J. H. Quastel (Montreal General Hospital) and Arnold Welch (Yale University). Quastel reviewed certain historical aspects of drug action in terms of enzyme inhibition and summarized recent work of his laboratory on the mechanism of action of narcotics and local anesthetics. These drugs have been found to inhibit the respiration of brain slices, but they inhibit more profoundly the increased respiration that results from stimulation by potassium ions or electric current.

After a useful concise summary of nucleotide biosynthesis, Welch discussed the action of specifically designed nucleic acid antimetabolites, a class of drugs that at present offers considerable hope for the rationally directed control of malignant disease in human beings. Earl Sutherland (Western Reserve University), a commentator on this portion of the program, described the stimulation by glucagon and epinephrine of phosphorylase activity. The epinephrine effect appears to be stimulation of a kinase that resynthesizes active phosphorylase from its inactive dephosphorylated form.

The final paper of the symposium, by Carl Cori (Washington University), presented anaerobic muscular contraction as a problem in the kinetic regulation of glycolysis. Thus, electric stimulation can in a fraction of a minute increase by 1800 times the rate of glycogen breakdown over that of the resting state, followed by equally rapid restoration. Cori considered the question of which enzymatic step is limiting and how its rate is so rapidly and smoothly adjusted to physiologic requirements. The observations presented suggest that the level of active phosphorylase may be a crucial factor.

Henry Lardy (University of Wisconsin), as a final commentator, proposed another mode of regulating reaction rates, exemplified by inhibition of the phosphohexokinase reaction by high ratios of ATP to Mg^{++} ion. Teleologically, this has been interpreted as a mechanism for conserving ATP, which might otherwise be wasted through the action of phosphatase on hexose diphosphate.

The general discussion following formal presentations will be fully included in the published proceedings, which should greatly enrich the value of the book. An analyst of scientific fashion could perhaps infer many foci of future interest from a record of this discussion. Certain questions of particular interest that arose in the discussion can be cited as random examples: a lively debate on protein turnover in animal and bacterial cells, the relationship of ATP hydrolysis to muscle contraction, the adequacy of the detailed reaction schemes that were offered for photosynthesis and electron transport, and, in the final session, the presentation of various impromptu models for the mechanism of active transport across biological membranes.

Two additional formal portions of the program must be mentioned—the Edsel B. Ford lecture that was presented on the first evening by Linus Pauling (California Institute of Technology) and a talk on the second evening by Albert Szent-Gyorgyi (Marine Biological Laboratory, Woods Hole). Both presentations were general and speculative in nature and served as agreeable carminatives after the concentrated fare of the

daily sessions. Pauling discussed molecular specificity and structural complementarity in reactions by biological importance, exemplified by his work on antibody reactions and on the "molecular disease," sickle cell anemia. Szent-Gyorgyi, in generalizing from the reactions of myosin and ATP, speculated that the past successes of biochemistry—in his image, the bright spots in the chiaroscuro of biological understanding—have dealt with systems that can be adequately treated in terms of classical molecular models. He surmised that the problems that are still fundamentally obscure, such as the transduction of chemical to mechanical and electric energy in muscle and nervous tissue, may require the additional sophistications of quantum chemistry.

Finally, it is interesting to consider the profits of a meeting such as this. For the most part, the papers presented were general reviews of the status and problems of major sectors of research in genetics, metabolism, cytology and cell physiology, particularly as these interpenetrate and overlap. It would seem that the outstanding value of such a symposium is mutual education via the authoritative presentation of problems and approaches across adjacent lines of inquiry. The ultimate success of the symposium as an agency of cross-fertilization is incalculable; as a stimulating intellectual and educational experience, its immediate success was pronounced by a number of the participants and undoubtedly by most of those in attendance.

ELIJAH ADAMS
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Meeting Notes

■ Fatigue of metals, increasingly important in the design and construction of modern aircraft for safety and performance, will be discussed by 125 invited delegates at a 3-day International Conference on Fatigue in Aircraft Structures at Columbia University, 30 Jan.–1 Feb. The meeting, under the auspices of the Columbia School of Engineering's department of civil engineering and engineering mechanics and its Institute of Flight Structures, is jointly sponsored by the Office of Scientific Research, U.S. Air Force.

It is believed that fatigue of materials has been responsible for about 20 percent of aircraft failure, including the two British jet-transport Comet disasters. Much attention has been given to strengthening alloys and structures without significant regard for fatigue performance.

The purpose of this international conference on fatigue will be, according to

Alfred M. Freudenthal, chairman of the organizing committee, "to increase the scope of basic research in fatigue in this country; to exchange information on research here and abroad in order to advance present researches and stimulate new ones and to provide, in published proceedings, a source of up-to-date information on fatigue for wider use."

Authorities in the field from England, Scotland, West Germany, Sweden, Australia, and the United States will present the principal aspects of the problem under three general headings: "Physical theories of fatigue"; "Prediction of fatigue life and fatigue strength"; and "Prevention of fatigue failure."

■ The AAAS Southwestern and Rocky Mountain Division will meet from 29 Apr. to 3 May at Las Cruces, N.M. Frank E. E. Germann, executive secretary of the division, has announced that the date for final submission of title with detailed statement of problem, or title with a 200-word abstract, is 1 Mar.

During the meeting the AAAS Arid Lands Committee will conduct a half-day symposium reviewing the work of the International Arid Lands Symposium that took place last spring in Albuquerque and Socorro under the sponsorship of the division, the AAAS, and UNESCO. Marlowe G. Anderson, chairman of the

local committee, is planning a series of social and general sessions. Participants will enjoy the hospitality of the New Mexico College of Agriculture and Mechanic Arts.

The 1956 section officers to whom titles are to be sent are as follows:

Botanical sciences. Chairman, Earl D. Camp, Texas Technological College, Lubbock; secretary, J. L. Gardner, Box 35, State College, N.M.

Physical sciences. Chairman, Marvin H. Wilkening, New Mexico Institute of Mining and Technology, Socorro; secretary, E. E. Burgoyne, Arizona State College, Tempe.

Social sciences. Chairman, Sophie D. Aberle, University of New Mexico, Albuquerque; secretary, Stanley S. Newman, University of New Mexico, Albuquerque.

Zoological sciences. Chairman, Rex Allen, New Mexico College of Agriculture and Mechanic Arts, Las Cruces; secretary, Roy E. Gilmore, New Mexico College of Agriculture and Mechanic Arts, Las Cruces.

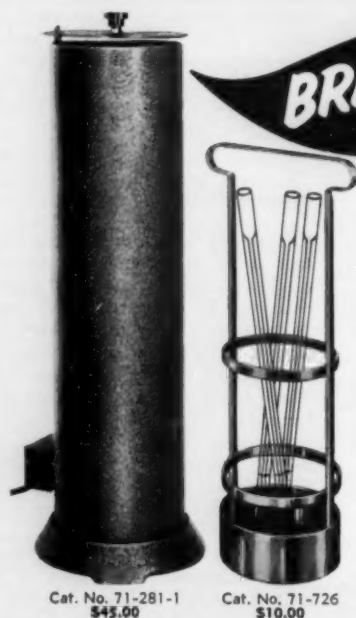
■ The fifth annual symposium on blood was held at the Wayne University College of Medicine on 21 Jan. under the chairmanship of Walter H. Seegers, physiology professor at Wayne. Some 200 scientists from throughout the

United States and Europe attended the meeting, where 15 papers dealing with fundamental problems and research in blood composition, hemophilia, and thrombosis were presented. Presiding with Seegers was Elwood A. Sharp, medical assistant to the president of Parke, Davis and Company. Calvin H. Hughes, biologist on the research staff of the General Motors Corporation, served as a member of the organizing committee.

A paper was presented on the practical problems of blood freezing and preservation by Harold T. Meryman, now at Yale University School of Medicine. Another paper, by Frank Monkhouse of the University of Toronto, dealt with the effects of severe irradiation on the blood.

A paper by three scientists from the University of Zurich, Switzerland, discussed a new clotting factor in the blood stream. The new serum factor, factor X, was described by François Duckert, P. Fluckinger, and Fritz Koller. Duckert at present is conducting research at Wayne.

Four other papers, including one by Seegers and Shirley A. Johnson of Wayne University, dealt with various types of hemophilia. Other papers on that subject were delivered by participants from Columbia University, Stanford University, and Harvard University.



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Three papers on thrombosis were presented by research men from Purdue University, the Naval Medical Research Institute, and Washington University. The formation and construction of thrombin was discussed in three other papers prepared by specialists from the New York State Health Department, the Army Research Laboratory at Ft. Knox, Ky., and Chicago's Presbyterian Hospital.

John W. Rebuck, from Henry Ford Hospital, Detroit, Mich., discussed the formation of red corpuscles in the bone marrow. A report on the chemical reactions of white blood cells was presented by William N. Valentine and John S. Lawrence of the University of California, Los Angeles.

Society Elections

■ American Chemical Society: pres., John C. Warner, Carnegie Institute of Technology; pres.-elect, Roger J. Williams, University of Texas; exec. sec., Alden H. Emery, ACS Bldg., 1155 16 St. NW, Washington 6, D.C.; treas., Robert V. Mellefont, ASC Bldg., 1155 16 St. NW, Washington 6, D.C.

■ American Microscopical Society: pres., R. W. Pennak, University of Colorado; 1st v. pres., C. O. Berg; 2nd v. pres., W. C. Frohne; sec.-ed., C. J. D. Brown, Montana State College; treas., L. O. Nolf. Representatives to the AAAS Council are Ralph V. Bangham and Horace W. Stunkard.

■ Poultry Science Association: pres., J. H. Quisenberry; 1st v. pres., T. B. Avery; 2nd v. pres., H. R. Bird; sec.-treas., C. B. Ryan, Texas A. & M. College.

■ Society for the Scientific Study of Religion: pres., Richard V. McCann, Harvard University; v. pres., Werner Wolff; sec., Walter Houston Clark, Hartford Seminary Foundation; treas., Jacqueline Y. Sutton.

Forthcoming Events

February

19-23. American Inst. of Mining and Metallurgical Engineers, New York, N.Y. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

19-23. Soc. of Economic Geologists, New York, N.Y. (O. N. Rove, Union Carbide and Carbon Corp., New York 17.)

20-22. American Educational Research Assoc., annual, Atlantic City, N.J. (F. W. Hubbard, AERA, 1201 16 St., NW, Washington 6.)

23-25. National Soc. of College Teachers of Education, Chicago, Ill. (C. A. Eggertsen, School of Education, Univ. of Michigan, Ann Arbor.)

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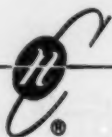
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24-25. American Physical Soc. Houston, Tex. (K. K. Darrow, APS, Columbia Univ., New York 27.)

27-2. American Soc. for Testing Materials, Buffalo, N.Y. (ASTM, 1916 Race St., Philadelphia 3, Pa.)

26-29. American Inst. of Chemical Engineers, Los Angeles, Calif. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

28-29. Scintillation Counter Symposium, 5th, Washington, D.C. (G. A. Morton, RCA Laboratories, Princeton, N.J.)

March

2-4. National Wildlife Federation, New Orleans, La. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

3-4. National Conf. and Workshop on Radio and Television Weather Presentation sponsored by American Meteorological Soc., Hartford, Conn. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

9-10. Midwest Conf. on Theoretical Physics, Iowa City, Iowa. (J. M. Jauch, Dept. of Physics, State Univ. of Iowa, Iowa City.)

12-16. National Assoc. of Corrosion Engineers, 12th annual, New York, N. Y. (Secretary, NACE, Southern Standard Bldg., Houston 2, Tex.)

14-17. National Science Teachers Assoc., Washington, D.C. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

15-16. Food Physics Symposium, 1st international, San Antonio, Tex. (C. W.

Smith, Southwest Research Inst., San Antonio.)

15-17. American Orthopsychiatric Assoc., 33rd annual, New York, N.Y. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

15-17. American Physical Soc., Pittsburgh, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27.)

15-17. Kappa Delta Pi, annual, Stillwater, Okla. (E. I. F. Williams, 238 E. Perry St., Tiffin, Ohio.)

16-18. International Assoc. for Dental Research, St. Louis, Mo. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

17-18. National Soc. of Professional Engineers, annual spring, Washington, D.C. (K. E. Trombley, NSPE, 1121 15 St., NW, Washington 5.)

18-24. American Soc. of Photogrammetry, annual, joint meeting with American Cong. on Surveying and Mapping, Washington, D.C. (ACSM-ASP, Box 470, Washington 4.)

19-21. Div. of Fluid Dynamics, American Physical Soc., Pasadena, Calif. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

19-22. American Acad. of General Practice Scientific Assembly, 8th annual, Washington, D.C. (AAGP, Broadway at 34th, Kansas City 11, Mo.)

19-22. Inst. of Radio Engineers National Convention, New York. (E. K. Gammett, IRE, 1 E. 79 St., New York 21.)

19-23. American Soc. of Tool Engi-

neers, Chicago, Ill. (H. G. Miller, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

21-22. National Health Forum, New York, N.Y. (T. G. Klumpp, National Health Council, 1790 Broadway, New York 19.)

21-23. American Power Conf., 18th annual, Chicago, Ill. (R. A. Budenholzer, Illinois Inst. of Technology, Chicago 16.)

21-24. American Astronomical Soc. Columbus, Ohio. (J. A. Hynek, McMillin Observatory, Ohio State Univ., Columbus.)

23-24. Eastern Psychological Assoc., Atlantic City, N.J. (G. G. Lane, Univ. of Delaware, Newark.)

24-25. American Psychosomatic Soc., 13th annual, Boston, Mass. (T. Lidz, APS, 551 Madison Ave., New York 22.)

24-31. Perspectives in Marine Biology, La Jolla, Calif. (A. A. Buzzati-Traverso, Scripps Institution of Oceanography, La Jolla.)

25-28. American Assoc. of Dental Schools, annual, St. Louis, Mo. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

25-29. American College Personnel Assoc., Washington, D.C. (Miss C. M. Northrup, Univ. of Denver, Denver, Colo.)

28-3. Colloquium on Frontiers in Physical Optics, Boston, Mass. (S. S. Ballard, Visibility Laboratory, Scripps Institution of Oceanography, San Diego 52, Calif.)

(See issue of 20 January for comprehensive list)

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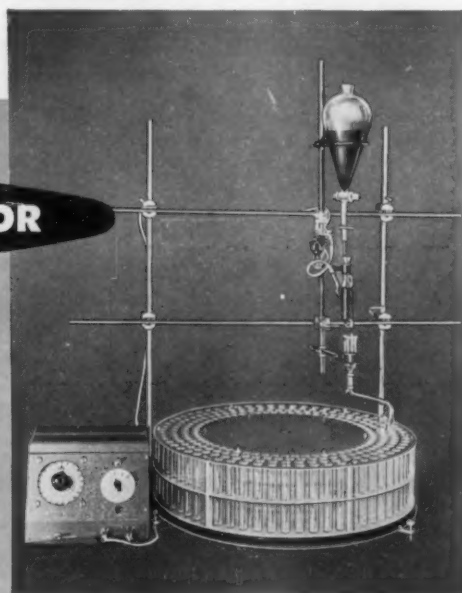
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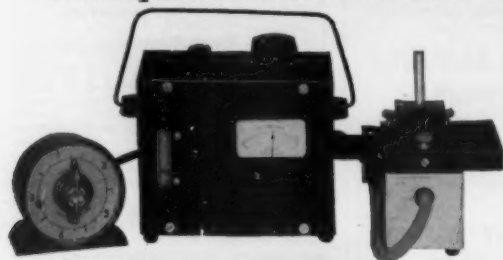
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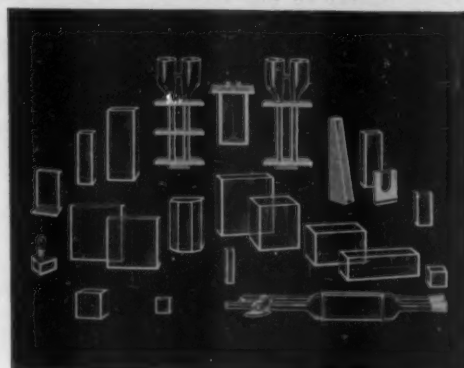
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Equipment News

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■ **PORTABLE AUTOCLAVE** of 6-gal capacity is electrically heated and has a thermostatic control. The unit, which weighs 24 lb, is designed for use in laboratory operations that necessitate an elevated temperature, under pressure, in a water-vapor atmosphere. The cast-aluminum body and cover are designed for pressures in excess of the normal rating of the unit. Pressure and temperature are controlled by means of a thermo switch, which is supplemented by a dial control

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■ **RAYOTUBE HEAT-RADIATION DETECTORS** of the 8890 series, which are designed for continuous temperature measurement to 5000°F and beyond, are described in a 24-page illustrated catalog that includes discussion of the theory behind heat-radiation measurements and tabulations of the characteristics of the detectors available. Catalog EN-S3. (Leeds and Northrup Co., Dept. Sci., 4934 Stenton Ave., Philadelphia 44, Pa.)

■ **PIPETTE DRYER** consists of a cylinder mounted on a vented base and a specially designed heater that is mounted at the lower end of the cylinder. As the hot air from the heater rises, it passes up and around and through the pipettes. Moisture is carried out through the vented top. Pipettes of any size up to 375 mm in length can be dried. The instrument is designed to take the standard rack of a 6-in. pipette washer. The rack may be taken out of the washer with its load of pipettes, drained for about 1 min, and placed in the dryer. (Phipps and Bird, Inc., Dept. Sci., 6 and Byrd Streets, Richmond 5, Va.)

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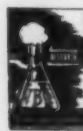
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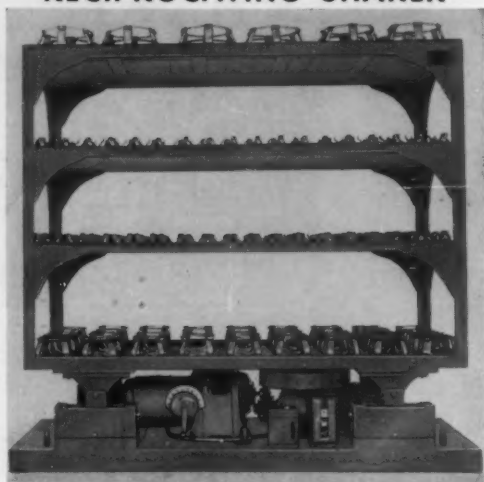
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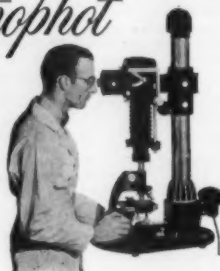
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